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ABSTRACT

Based on hypotheses on relationships between curiosity, anxiety, and performance, this study correctly predicted that high state curiosity students had lower levels of state anxiety and performed better in the computer-assisted instruction learning program than low state curiosity students. One hundred and fifty-two female undergraduates were equally assigned to Curiosity-Stimulating Instruction (CSI) or No Instruction (NI) groups. The hypothesis that the CSI students would perform better than the NI students was only partially supported. Contrary to predictions neither state anxiety nor state curiosity differed for students in CSI and NI conditions. The author concluded that the State Epistemic Curiosity Scale was found to have a high internal consistency and substantial concurrent and construct validity. (MC)

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THE EFFECTS OF STIMULATING STATE EPISTEMIC CURIOSITY ON STATE ANXIETY AND PERFORMANCE IN A COMPLEX COMPUTER–ASSISTED LEARNING TASK

Barbara L. Leherissey

Tech Report No. 23
December 1, 1971

Project NR 154-280
Sponsored by
Personnel & Training Research Programs
Psychological Sciences Division
Office of Naval Research
Arlington, Virginia
Contract No. NOO14-68-A-094

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The present study sought to: (a) investigate the hypothesis that stimulating state epistemic curiosity within a complex Computer-Assisted Instruction (CAI) task would reduce state anxiety and improve performance; (b) assess further the reliability and validity of the State Epistemic Curiosity Scale ~~(SECS;~~ Leherissey, 1971b); and (c) integrate the findings within the theoretical framework of the Optimal Degree of Arousal concept.

Subjects were 152 female undergraduates enrolled in psychology and education classes. Their trait curiosity and trait anxiety differences were ascertained by extreme scores on the Ontario Test of Intrinsic Motivation (OTIM; Day, 1968) and the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970), and these scores were the basis for equal assignment to Curiosity-Stimulating Instruction (CSI) or No Instruction (NI) conditions within a Reading (R) or Constructed Response (CR) program version. Curiosity-Stimulating Instructions presented prior to the learning materials were

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designed to increase desire to (a) know more about a learning task; (b) approach a novel or unfamiliar learning task; (c) approach a complex or ambiguous learning task; and (d) persist in information-seeking behavior in a learning task. Students in the NI condition were given a brief rest in place of these instructions.

The CAI learning program consisted of technical materials explicating myocardial infarction diagnosis. State epistemic curiosity, as measured by the SECS, and state anxiety, as measured by the STAI, were assessed periodically via CAI.

Hypotheses on relationships between curiosity, anxiety, and performance were derived from the Optimal Degree of Arousal concept which provides a theoretical model for these predictions. As predicted, (a) high state curious students had lower levels of state anxiety and performed better than low state curious students; and (b) high trait curious students had higher state curiosity scores than low trait curious students.

The hypothesis that students in the CSI condition would perform better than students in the NI condition was only partially supported in that (a) high state anxious students in the CSI condition performed better than high state anxious students in the NI condition, whereas there was little difference in the performance of low state anxious students in these conditions; (b) both low trait and low state curious students in the CSI condition performed better than low trait or low state curious students in the NI condition, whereas there was little difference in the performance of high trait or state curious students in these conditions; and (c) in the CSI condition, the CR group performed better than the R group, whereas there was little difference in the performance of either group in the NI condition.

Contrary to predictions, neither state anxiety nor state curiosity differed for students in the CSI and NI conditions. Regardless of instruction conditions, initially high curiosity declined throughout the CAI task. However, the CR groups had a greater decline in state curiosity and increase in state anxiety than the R groups. In addition, only high trait curious and low trait anxious students in the R groups maintained their initial high levels of state curiosity and low levels of state anxiety, respectively, throughout the CAI task.

With respect to the reliability and validity findings, the SECS was found to have high internal consistency and substantial concurrent and construct validity. The findings were generally supportive of the predictions derived from the Optimal Degree of Arousal concept. On the basis of an integration of the data collected, however, extensions and refinements of the Optimal Degree of Arousal concept were offered via a new theoretical model, the Three Factor Model.

TABLE OF CONTENTS

ABSTRACT vii
LIST OF TABLES ix
LIST OF FIGURES xiii

Chapter
- I. INTRODUCTION 1
  - The Optimal Degree of Arousal Model 2
  - Evidence of the Relationship Between Curiosity and Anxiety 9
  - Trait Measures of Curiosity 12
  - Development of a Measure of State Epistemic Curiosity 13
  - Statement of the Problem 16

- II. METHOD AND PROCEDURES 18
  - Curiosity Measures 18
  - Anxiety Measures 19
  - Selection of Subjects 20
  - Apparatus 20
  - Learning Materials and Program Description 20
  - Achievement Measures 22
  - Procedure 22
    - Pretask Period 22
    - Performance Period 23
    - Posttask Period 24

- III. ANALYSIS OF DATA 25
  - Reliability and Validity of Personality Inventories 25
      - State Epistemic Curiosity Scale Reliability 25
      - OTIM and SSS Scales Reliability 29
      - STAI Scale Reliability 29
    - State Epistemic Curiosity Scale Validity Results 31
      - Concurrent Validity 31
      - Construct Validity 32
  - Curiosity and Performance Results 38
    - Curiosity Analyses 38
      - Effects of Response Mode and Instruction Conditions on In-Task Curiosity Scores for Low and High Trait Curious Students 38
      - Effects of Response Mode and Instruction Conditions on Pre- and Post-Task State Curiosity Scores for Low and High Trait Curious Students 40
    - Curiosity and Performance Analyses 44
      - Effects of Response Mode and Instruction Conditions on Posttest Performance for Low and High Trait Curious Students 44

      Effects of Response Mode and Instruction Conditions on Posttest Performance for Low, Medium, and High State Curious Students 44
         In-Task State Curiosity Analyses 45
         Post-Task State Curiosity Analyses 46
Anxiety and Performance Results 52
   Anxiety Analyses 52
      Effects of Response Mode and Instruction Conditions on In-Task A-State Scores for Low and High A-Trait Students 52
      Effects of Response Mode and Instruction Conditions on Posttest A-State Scores for Low and High A-Trait Students 56
   Anxiety and Performance Analyses 57
      Effects of Response Mode and Instruction Conditions on Posttest Performance for Low and High A-Trait Students 57
      Effects of Response Mode and Instruction Conditions on Posttest Performance for Low, Medium, and High A-State Students 57
         Posttest A-State Analyses 59
         In-Task A-State Analyses 60
Curiosity, Anxiety, and Performance Results 64
   Trait Curiosity and State Anxiety Analyses 64
      Effects of Response Mode and Instruction Conditions on In-Task A-State Scores for Low and High Trait Curious Students 64
   Trait Anxiety and State Curiosity Analyses 67
      Effects of Response Mode and Instruction Conditions on In-Task State Curiosity Scores for Low and High Trait Anxious Students 67
      Effects of Response Mode and Instruction Conditions on Posttask State Curiosity Scores for Low and High Trait Anxious Students 69
   State Curiosity and State Anxiety Analyses 69
      Effects of Response Mode and Instruction Conditions on In-Task A-State Scores for Low, Medium, and High State Curious Students 69
      Effects of Response Mode and Instruction Conditions on Posttest A-State Scores for Low, Medium, and High State Curious Students 72
Integration of Curiosity, Anxiety, and Performance Analyses Within the Framework of the Optimal Degree of Arousal Model 75

Integration of Curiosity, Anxiety, and Performance Analyses Within the Framework of the Optimal Degree of Arousal Model 75

Predicted Relationships Between Curiosity and Anxiety 77
Predicted Existence and Ordering of Curiosity/Anxiety Categories ..80
Predicted Relationships between Curiosity, Anxiety, and Performance 81

IV. DISCUSSION 89
Validation of State Epistemic Curiosity Scale 89
Effects of Stimulating State Epistemic Curiosity on State Anxiety and Performance 90
Integration of Present Findings Within Optimal Degree of Arousal Conceptualization 95
Conclusion 102

REFERENCES 104

APPENDICES 109

A. ORIGINAL VERSIONS OF THE STATE EPISTEMIC CURIOSITY SCALE USED IN STUDIES I AND II 111
B. REVISED LONG AND SHORT FORMS OF THE STATE EPISTEMIC CURIOSITY SCALE USED IN THE PRESENT STUDY 117
C. EXAMPLES OF THE INITIAL TECHNICAL AND REMAINING TECHNICAL LEARNING MATERIALS 125
D. RATIONALE AND PROCEDURES FOR SELECTING THE CURIOSITY–STIMULATING INSTRUCTIONS 129
E. EFFECT OF TREATMENT VARIABLES ON PRE-TASK MEASURES 135
F. EFFECT OF TREATMENT VARIABLES ON TOTAL TIME SPENT ON THE CAI TASK 145
G. REPLICATION RESULTS OF TWO PREVIOUS CAI STUDIES WITH THE SAME LEARNING MATERIALS 155
H. EFFECT OF TREATMENT VARIABLES ON CAI LEARNING PROGRAM PERFORMANCE FOR STUDENTS IN THE CONSTRUCTED RESPONSE GROUPS 165

VITA 175

THE EFFECTS OF STIMULATING STATE EPISTEMIC CURIOSITY ON STATE ANXIETY AND PERFORMANCE IN A COMPLEX COMPUTER-ASSISTED LEARNING TASK

Barbara L. Leherissey
The Florida State University

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With respect to the reliability and validity findings, the SECS was found to have high internal consistency and substantial concurrent and construct validity. The findings were generally supportive of the predictions derived from the Optimal Degree of Arousal concept. On the basis of an integration of the data collected, however, extensions and refinements of the Optimal Degree of Arousal concept were offered via a new theoretical model, the Three Factor Model.

LIST OF TABLES

TABLE

1. The Interrelationships Between Major Classes of Curiosity Behaviors 4
2. Means, Standard Deviations, and Alpha Reliabilities of Eight State Epistemic Curiosity Scales Administered During Experiment (N=152) 26
3. Means, Standard Deviations, and Item-Remainder Correlations for the Pretask and Posttask State Epistemic Curiosity Scales (N=152) 26
4. Means Standard Deviations, and Item-Remainder Correlations for the Six In-Task State Epistemic Curiosity Scales (N=152) 28
5. Means, Standard Deviations and Alpha Reliability Coefficients for the OTIM Subscales and OTIM Total Scale (N=152) 30
6. Means, Standard Deviations, and Alpha Reliabilities of the STAI A-Trait and A-State Scales Administered During the Experiment (N=152) 31
5. Correlations of Pre-Task and Post-Task SECS Scales with OTIM Total Scale and OTIM Subscales (N=152) 32
8. Correlations of Six In-Task Short Form SECS Scales with OTIM Total Scale and OTIM Subscales (N=152) 33
9. Correlation Matrix of the Eight SECS Scales and Eight STAI A-State Scales (N=152) 34
10. Correlations of the 20-Item and Short Form State Epistemic Curiosity Scales with the STAI A-Trait Scale (N=152) 36
11. Correlations of Eight State Epistemic Curiosity Measures with Posttest Achievement Measures (N=152) 37
12. Correlations of the 20-Item and Short Form SECS Scales with the Sensation Seeking Scale (N=152) 38
13. Mean State Curiosity Scores on the Six In-Task SECS Measures for Low and High Trait Curious Students in Response Mode and Instruction Conditions 39
14. Mean State Curiosity Scores on the Pre- and Post-Task SECS Measure for Low and High Trait Curious Students in Response Mode and Instruction Conditions 43
15. Mean Correct Responses on the Initial Technical Posttest for Low and High Trait Curious Students in Response Mode and Instruction Conditions 45
16. Mean Correct Responses on the Remaining Technical Posttest for Low and High Trait Curious Students in Response Mode and Instruction Conditions 46
17. Mean Correct Responses on the Initial Technical Posttest for Low, Medium, and High In-Task State Curiosity Students in Response Mode and Instruction Conditions 48

18. Mean Correct Responses on the Remaining Technical Posttest for Low, Medium, and High In-Task State Curiosity Students in Response Mode and Instruction Conditions 49
19. Mean Correct Responses on the Initial Technical Posttest for Low, Medium, and High Post-Task State Curious Students in Response Mode and Instruction Conditions 50
20. Mean Correct Responses on the Remaining Technical Posttest for Low, Medium, and High Post-Task State Curious Students in Response Mode and Instruction Conditions 51
21. Mean A-State Scores on Six In-Task STAI A-State Measures for Low and High A-Trait Students in Response Mode and Instruction Conditions 53
22. Mean A-State Scores on the Posttest A-State Measure for Low and High A-Trait Students in Response Mode and Instruction Conditions 56
23. Mean Correct Responses on the Initial Technical Posttest for Low and High A-Trait Students in Response Mode and Instruction Conditions 58
24. Mean Correct Responses on Remaining Technical Posttest for Low and High A-Trait Students in Response Mode and Instruction Conditions 59
25. Mean Correct Responses on the Initial Technical Posttest for Low, Medium, and High Posttest A-State Students in Response Mode and Instruction Conditions 60
26. Mean Correct Responses on the Remaining Technical Posttest for Low, Medium, and High Posttest A-State Students in Response Mode and Instruction Conditions 61
27. Mean Correct Responses on the Remaining Technical Posttest for Low, Medium, and High In-Task A-State Students in Response Mode and Instruction Conditions 62
28. Mean Correct Responses on the Remaining Technical Posttest for Low, Medium, and High In-Task A-State Students in Response Mode and Instruction Conditions 63
29. Mean A-State Scores on the Six In-Task STAI A-State Measures for Low and High Trait Curious Students in Response Mode and Instruction Conditions 65
30. Mean STAI A-State Scores on the Posttest A-State Measure for Low and High Trait Curious Students in Response Mode and Instruction Conditions 67
31. Mean State Curiosity Scores on Six In-Task SECS Measures for Low and High A-Trait Students in Response Mode and Instruction Conditions 68
32. Mean State Curiosity Scores on the Pre and Posttask SECS Measure for Low and High A-Trait Students in Response Mode and Instruction Conditions 70

33. Mean A-State Scores on the Six In-Task STAI A-State Measures for Low, Medium, and High In-Task State Curious Student in Response Mode and Instruction Conditions 71
34. Mean A-State Scores on the Posttest STAI A-State Measure for Low, Medium, and High In-Task State Curious Students in Response Mode and Instruction Conditions 73
35. Mean A-State Scores on the Posttest STAI A-State Measure for Low, Medium, and High Posttask State Curious Students in Response Mode and Instruction Conditions 74
36. A Comparison of the predictions Derived from the One Factor, Two Factor, and Three Factor Models 100
37. Mean OTIM Scores for Low and High A-Trait Students in Response Mode and Instruction Conditions 137
38. Mean Sansation Seeking Scale Scores for Low and High A-Trait Students in Response Mode and Instruction Conditions 138
39. Mean Sansation Seeking Scale Scores for Low and High Trait Curious Students in Response Mode and Instruction Conditions 139
40. Mean STAI A-Trait Scores for Low and High Trait Curious Students in Response Mode and Instruction Conditions 140
41. Mean State Curiosity Scores on the Pretask SECS Measure for Low and High Trait Curious Students in Response Mode and Instruction Conditions 141
42. Mean State Curiosity Scores on the Pretask SECS Measure for Low and High A-Trait Students in Response Mode and Instruction Conditions 142
43. Mean STAI A-State Scores on the Pretask A-State Measure for Low and High A-Trait Students in Response Mode and Instruction Conditions 143
44. Mean STAI A-State Scores on the Pretask A-State Measure for Low and High Trait Curious Students in Response Mode and Instruction Conditions 144
45. Mean Learning Times on the CAI Program for Low and High Trait Curious Students in Response Mode and Instruction Conditions 147
46. Mean Learning Times on the CAI Program for Low, Medium, and High In-Task State Curious Students in Response Mode and Instruction Conditions 148
47. Mean Learning Times on the CAI Program for Low, Medium, and High Posttask State Curious Students in Response Mode and Instruction Conditions 149
48. Mean Learning Times on the CAI Program for Low and High A-Trait Students in Response Mode and Instruction Conditions 150
49. Mean Learning Times on the CAI Program for Low, Medium, and High In-Task State Anxious Students in Response Mode and Instruction Conditions 152

50. Mean A-State Scores on the Six In-Task STAI A-State Measures for Low and High A-Trait Students in Response Mode Conditions 158
51. Mean A-State Scores on the Posttask A-State Measure for Low and High A-Trait Students in Response Mode Conditions 159
52. Mean Correct Responses on the Initial Technical Posttest for Low and High A-Trait Students in Response Mode Conditions 160
53. Mean Correct Responses on the Remaining Technical Posttest for Low and High A-Trait Students in Response Mode Conditions 161
54. Mean Correct Responses on the Total Technical Posttest for Low and High A-Trait Students in Response Mode Conditions 161
55. Mean Correct Responses on the Initial Technical Learning Program for Low and High Trait Curious Students in Instruction Conditions 168
56. Mean Correct Responses on the Remaining Technical Learning Program for Low and High Trait Curious Students in Instruction Conditions 168
57. Mean Correct Responses on the Initial Technical Learning Program for Low, Medium, and High State Curious Students in Instruction Conditions 170
58. Mean Correct Responses on the Remaining Technical Learning Program for Low, Medium, and High State Curious Students in Instruction Conditions 171
59. Mean Correct Responses on the Initial Technical Learning Program for Low and High Trait Anxious Students in Instruction Conditions 172
60. Mean Correct Responses on the Remaining Technical Learning Program For Low and High Trait Anxious Students in Instruction Conditions 172
61. Mean Correct Responses on the Initial Technical Learning Program for Low Medium, and High In-Task A-State Students in Instruction Conditions 173
62. Mean Correct Responses on the Remaining Technical Learning Program for Low, Medium, and High In-Task A-State Students in Instruction Conditions 173

LIST OF FIGURES

Figure

1. Concepts of curiosity behaviors and their associated measurement instruments 5
2. The optimal degree of arousal model 7
3. Illustration of how students in CR versions "drew" EKG tracings via CAI 21
4. Experimental sequence of events in study 23
5. Response modes by levels of trait curiosity by measurement periods interaction on state curiosity scores 41
6. Response modes by measurement periods interaction on state curiosity scores 42
7. Instruction conditions by trait curiosity levels interaction on initial technical posttest scores 47
8. Instruction conditions by response modes interaction on remaining technical posttest scores 50
9. Instruction conditions by levels of post-task state curiosity levels on remaining technical psottest scores 51
10. Response modes by measurement periods interaction on in-task state anxiety scores 54
11. Response modes by levels of trait anxiety by measurement periods interaction on in-task state anxiety scores 55
12. Instruction conditions by posttest A-State levels interaction on initial technical posttest scores 61
13. Response modes by in-task A-State levels interaction on initial technical posttest scores 63
14. Response modes by trait curiosity levels interaction on in-task A-State scores 66
15. Response modes by levels of in-task state curiosity by measurement periods interactions on in-task A-State scores 73
16. Response modes by post-task state curiosity levels interaction on posttest A-State scores 76
17. Relationship trait curiosity, trait anxiety, in-task measurement periods and state curiosity 78
18. Relationship between trait curiosity, trait anxiety, in-task measurement periods and state anxiety 79
19. Frequency of students in the CR groups falling into state anxiety/state curiosity categories 81
20. Frequency of students in the R groups falling into state anxiety/state curiosity categories 82
21. Relationships between trait anxiety/trait curiosity categories, response modes, instruction conditions and inial technical posttest performance 83

22. Relationships between trait anciety/trait curiosity categories, response modes, instruction conditions and remaining technical posttest performance 83
23. Relationships between in-task state curiosity, response modes, instruction conditions, and initial technical posttest performance 85
24. Relationships between in-task state anxiety, response modes instruction conditions, and initial technical posttest performance 85
25. Relationships between post-task state curiosity, response modes, instruction conditions, and initial technical posttest performance 85
26. Relationships between posttest state anxiety, response modes, instruction conditions, and initial technical posttest performance 85
27. A diagrammatic representation of the Three Factor Model for predicting relationships between state diversive curiosity, state specific curiosity, and state anxiety within the Optimal Degree of Arousal concept 97
28. Instruction conditions by level of trait anxiety interaction on total learning time 151
29. Response modes by instruction conditions by level of trait anxiety interaction on total learning time 151
30. Response modes by measurement periods interaction on in-task state anxiety scores 159
31. Instruction conditions by levels of trait curiosity interaction on initial technical learning program scores 169
32. Instruction conditions by levels of trait curiosity interaction on remaining technical learning program scores 170

I. INTRODUCTION

One of the primary tasks facing today's educator is that of providing an optimal learning environment in which efficient student learning can occur. The task of specifying such an optimal learning environment requires that both the instructional situation and learner characteristics be taken into consideration. An instructional system which offers a natural yet controlled setting for studying the optimization of the learning environment is Computer-Assisted Instruction (CAI). The convenient natural setting of the CAI system makes it possible to evaluate the effects of instructional strategies on the learning process under more carefully controlled experimental conditions than is possible in traditional instructional settings. All student responses to learning materials and personality measures are recorded by the CAI system, thereby providing a basis for individualized decision strategies that maximize student learning efficiency.

A characteristic of the learner which is of primary importance for optimal learning is his internal sources of motivation, or his level of curiosity toward the learning task. Recent research evidence from a variety of sources now suggests that the stimulation of curiosity behaviors enhances the acquisition of knowledge and the development of cognitive structures (e.g., Berlyne, 1960, 1967, 1971; Charlesworth, 1969; Day, 1967, 1969c; Piaget, 1968). In addition, Leherissey (1971a) summarized the research on curiosity as it relates to learning and instructional strategies, and pointed out that a factor within the learner which may be detrimental to both the arousal of curiosity behaviors and optimal performance in a learning task is anxiety (Day, 1967, 1969a; Lester, 1968; Maslow, 1963). Thus, the purpose of the present study is to systematically investigate the effects of stimulating curiosity on the anxiety and performance of students presented a complex CAI learning task.

Research on anxiety and CAI learning has been clarified by the conceptual framework of Spielberger's Trait-State Anxiety Theory. According to Spielberger (1966), state anxiety (A-State) refers to a transitory state or condition of the organism that is characterized by feelings of tension or apprehension and heightened autonomic nervous system activity. Trait anxiety (A-Trait) implies individual differences in anxiety proneness, i.e., the disposition to respond with elevations in A-State under conditions that are characterized by some threat to self-esteem. Since state anxiety level would be expected to vary as a function of the individual's perception of a situation at a given point in time, periodic measures of A-State can provide an accurate assessment of the impact of instructional treatments on the learner. The State-Trait Anxiety Inventory (STAI) developed by Spielberger, Gorsuch, and Lushene (1970), has proven to be a viable research instrument for understanding the complex relationships between anxiety and performance in a CAI learning task (Leherissey, O'Neil, & Hansen, 1971; O'Neil, Spielberger, & Hansen, 1969; O'Neil, Hansen, & Spielberger, 1969).

Of particular importance for understanding the relationships between curiosity, anxiety, and performance is a theoretical model which specifies the relevant variables and their predicted relationships. The conceptualization of the major classes of curiosity behaviors has been provided by Berlyne (1960), who has also posited (Berlyne, 1967, 1971) an inverted-U relationship between reinforcement (pleasant versus unpleasant hedonic feelings) and arousal. Within this optimal arousal function, Spielberger and Butler (1971)[1] elaborated the relationships between diversive curiosity, specific curiosity, and anxiety, and the resulting theoretical model was named the Optimal Degree of Arousal Model (Leherissey, 1971a). The theoretical framework associated with this model and the curiosity phenomena will be discussed in the following section, after which research relevant to the relationship between curiosity and anxiety will be reviewed. Since the viability of any theoretical model is dependent upon appropriate measures of the relevant constructs, additional sections will review research efforts to develop measures of curiosity.

The Optimal Degree of Arousal Model

One of the first tasks confronting investigators of curiosity is that of providing an adequate definition of this phenomenon. In general, Berlyne (1960) defined curiosity as a motivational condition which results from collative variability or incomplete absorption of information about a particular stimulus. Berlyne (1960-1963) further recognized that it was necessary to distinguish between diversive and specific curiosity. Whereas diversive curiosity referred to that behavioral state in which the organism actively seeks out stimulation regardless of content and which is induced by a state of boredom, specific curiosity referred to that behavioral state in which the organism actively seeks to reduce his subjective uncertainty regarding specific stimuli and which is induced by incomplete information.

An additional distinction particularly important for the investigation of relationships between curiosity and learning is Berlyne's (1960) separation of two types of specific curiosity—epistemic and perceptual. For Berlyne (1960, p. 274), epistemic curiosity is "the brand of arousal that motivates the quest for knowledge and is relieved when knowledge is procured. We distinguish it from the perceptual curiosity that is reduced by exposure to appropriate stimuli." Although both perceptual and epistemic curiosity are aroused by lack or inadequacy of information, epistemic curiosity is aimed at not only acquiring sensory information, but at acquiring knowledge in order to reduce conceptual conflict. As such, epistemic curiosity if related to thinking and problem-solving behaviors. In addition, epistemic curiosity is a drive which is reducible by rehearsal of knowledge (Berlyne, 1960) and involves symbolic processes such as knowledge, thoughts, and concepts (Berlyne, 1963).

The importance of the concept of epistemic curiosity for a theory of motivation becomes apparent when one considers that much of man's activities are characterized by knowledge-seeking and thinking behaviors. As a motivational concept, epistemic curiosity provides the means by which conceptual conflict is both aroused and reduced by symbolic processes, and is the type of exploration which can lead to learning or permanent storage of information (Berlyne, 1971). Berlyne (1960) divides epistemic curiosity responses into three classes: (a) observation, in which an individual seeks out external situations that nourish pertinent learning processes; (b) thinking, in which an individual engages in productive or creative thinking that leads to permanent possession of new knowledge; and (c) consultation, in which an individual exposes himself to another individual's verbal stimuli through such actions as asking questions, writing letters, and reading.

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[1] The relationships between diversive curiosity, specific curiosity, and state anxiety shown in Figure 2 were further elaborated by Dr. C. D. Spielberger and T. F. Butler in a graduate seminar presented by Dr. D. E. Berlyne at Florida State University, Psychology Department, Feb. 11, 1971.

The function of epistemic curiosity, therefore, is held to be that of producing a lasting residue of knowledge, and as Berlyne (1960, p. 266) has stated, "The function of knowledge is to overcome the deficiencies of perception by providing internal stimuli, products of symbolic processes, to supplement the external stimuli that originate in outside objects." Since Berlyne (1960) sees thinking as being central to the acquisition of new knowledge, he feels that those motivational factors which affect epistemic behaviors in general affect thinking in particular. Thus, the interrelationships between curiosity, thinking, and learning are clarified.

Another important distinction made recently (Day, 1969c) is between specific curiosity as a personality trait and as a transitory state of the organism. Day (1969c, p. 6) notes, however, that Berlyne has tended to restrict his consideration of curiosity to the state condition and argues that "a person can be said to have a trait characteristic of curiosity if he has the propensity for either becoming curious (reactivity), and/or possibly remaining in a state of curiosity for longer periods of time (chronicity)." Regarding the state of curiosity, Day (1969b, p. 2) states, "a person is deemed to be curious when he is faced with a problem or situation which requires exploration and a willingness to puzzle out the solution to the problem."

When specific curiosity is viewed as a motivational variable (i.e., a state), research interest is directed toward specifying the parameters of this state and toward determining the effects on behavior of changes in this motivational state. Conceptual clarity is gained by the distinction between curiosity as a state and as a trait, which should hopefully lead to more adequate experimental predictions and procedures. The distinctions between the major classes of curiosity behaviors and their definitions are given in Table 1. In addition, a graphic representation of the various curiosity concepts and inventories currently available for measuring some of these concepts is shown in Figure 1. It should be noted that the trait measures of diversive and specific curiosity do not operationally distinguish epistemic and perceptual curiosity in their scale construction, whereas the State Epistemic Curiosity Scale (Leherissey, 1971b) was developed to measure the concept of state epistemic curiosity.

Once the relevant aspects of the curiosity phenomena have been adequately defined, the next task becomes that of specifying the relationships between major classes of curiosity behaviors, arousal level, feeling states, and performance. In Berlyne's (1960, 1963) earlier work, he suggested that organisms perform in order to reduce arousal, in that arousal was found to be high under both very novel or complex stimulus situations and very familiar or monotonous stimulus conditions. His further equation of drive or arousal-producing conditions with stimulus deprivation led Berlyne to suggest that exploratory behaviors were motivated by a curiosity drive. Drive-inducing properties were assigned to novel, unexpected or ambiguous stimuli, and conflict was assumed to be reduced through curiosity behaviors.

TABLE 1

The Interrelationships Between Major Classes of Curiosity Behaviors

Curiosity Behaviors	Definitions State	Trait
Specific Curiosity	Transitory state characterized by actively seeking to reduce subjective uncertainty by specific exploratory acts; induced by state of incomplete information regarding specific stimuli.	Relatively stable tendency or personality predisposition to engage in specific exploration under conditions of subjective uncertainty.
a) Epistemic	Transitory state of specific curiosity characterized by seeking to reduce subjective uncertainty by a quest for particular knowledge.	Relatively stable tendency or personality predisposition to engage in specific knowledge-seeking behaviors under conditions of conceptual conflict.
b) Perceptual	Transitory state of specific curiosity characterized by seeking to reduce subjective uncertainty by exposure to particular stimuli.	Relatively stable tendency or personality predisposition to engage in specific exploration of stimuli under conditions of perceptual conflict.
Diversive Curiosity	Transitory state of curiosity characterized by actively seeking diverse forms of stimulation; induced by a state of boredom.	Relatively stable tendency or personality predisposition to engage in diverse stimulation-seeking behaviors under conditions of boredom.

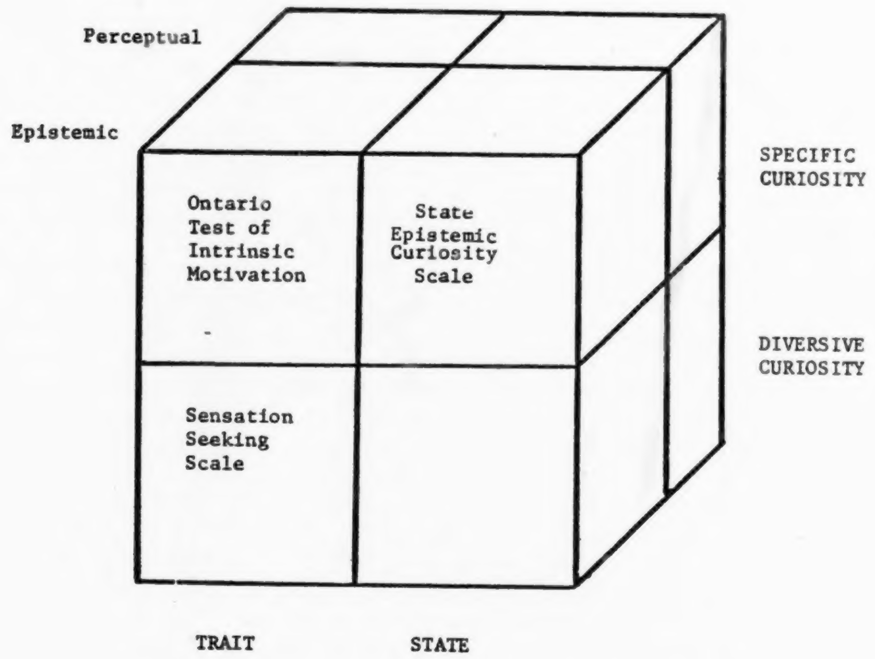
Perceptual
Epistemic
Ontario Test of Intrinsic Motivation
State Epistemic Curiosity Scale
Sensation Seeking Scale
SPECIFIC CURIOSITY
DIVERSIVE CURIOSITY
TRAIT
STATE

Figure 1.–Concepts of curiosity behaviors and their associated measurement instruments

In his later work, Berlyne (1967) again argued for an equation of arousal and drive on the basis of existing experimental evidence, and on the basis that indices of arousal would provide more convenient and direct measures of drive. Furthermore, Berlyne (1967) reviewed the literature relevant to the issue of whether increases in arousal versus decreases in arousal were reinforcing. He noted that there is empirical evidence in support of both these views, and rejected as inadequate his earlier (Berlyne, 1960) "boredom" and "arousal jag" mechanisms which were posited to account for both cases through arousal reduction. He still maintained the view that high levels of arousal were rewarding, and further, that the discomforting subjective feeling of boredom was associated with high arousal. However, Berlyne (1967, p. 29) stated, "Data from many different sources now compel us to entertain the hypothesis that reinforcement, and in particular reward, can result in some circumstances from an increase in arousal regardless of whether it is soon followed by a decrease."

Berlyne (1967), therefore, offered the hypothesis that it is degree of arousal increment which is critical, with moderate increases being rewarding and extreme increases being aversive. Implicit in this hypothesis is the assumption that there is an optimal, intermediate degree of arousal increase for effective learning. Berlyne (1967) then presented evidence from a variety of empirical studies which supported this hypothesis of optimal degree of arousal, or inverted-U hypothesis. The conclusions Berlyne (1967) draws include: (a) reinforcement is dependent on arousal potential; (b) arousal reduction is not necessarily reinforcing; (c) both reward and aversion systems exist physiologically and behaviorally, although these may not be opposing systems in that both are related to drive (arousal) and brought into play by different magnitudes of arousal increase; (d) the inverted-U function represents the way reward and aversion varies, both in terms of stimulus intensity and arousal value. In addition, he speculated that "satisfaction is at a maximum when the functions (physiological or psychological) are exercised most effectively" (Berlyne, 1967, p. 88).

More relevant to this theory of optimal degree of arousal and the present investigation is the theoretical model (Berlyne, 1971; Spielberger & Butler, 1971) which specifies the relationships between diversive curiosity, specific curiosity, and anxiety as a function of stimulus impact and hedonic feelings, i.e., pleasant versus unpleasant. A diagrammatic representation of this formulation is shown in Figure 2. Several points should be noted concerning this theoretical model: (a) the aversion threshold (anxiety drive) is higher than the reward threshold (curiosity drive), i.e., more intense increases in arousal activate the aversion system; (b) the inverted-U curve is the additive resultant of the separate reward and aversion systems; (c) both curiosity and anxiety are drive states that motivate the organism and which are activated by moderate or high degrees of arousal, respectively;[2] (d) diversive curiosity is rewarding through increases in stimulation toward the optimal level, whereas specific curiosity is rewarding through decreases in stimulation toward the optimal level; (e) specific curiosity is anxiety-reducing, whereas diversive curiosity tends to lead to increases in anxiety; and (f) an optimal degree of arousal exists for learning, in that performance is best under conditions of moderate or optimal degrees of arousal.

The work of Berlyne's former student, Day (1967, 1969c), has been directed in part to further clarifying the relationships between anxiety, curiosity, and arousal. Day (1967) has argued that level of arousal determines whether the direction of the response is anxiety or curiosity. Specifically, he has sought to identify the point on the arousal dimension where curiosity turns to anxiety, in that he does not view the two as separate drive states. In addition, in defining the affective zones of the inverted-U model, Day (1967, p. 14) concludes that "very mild stimulation is pleasurable, moderate stimulation is interesting, but strong stimulation leads to feelings of anxiety."

In discussing the apparent rewarding effects of reducing conflict (arousal) in specific curiosity behaviors, Day (1969c) suggests that the reward may lie in the information-processing behaviors themselves that are involved in arousal reduction. Thus, following completion of the process of epistemic curiosity, an organism may be motivated to find new complexities and incongruities to explore. The intrinsic

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[2] Whereas Berlyne (1960, 1967), Day (1969a), and Leherissey (1971a) view curiosity and anxiety as drive states activated by moderate or high levels of arousal, respectively, Spielberger and Butler have postulated a different theoretical position on the relationship between curiosity and anxiety. In essence, Spielberger and Butler maintain that curiosity and anxiety are separate, antagonistic drive states activated by separate reward and aversion systems.

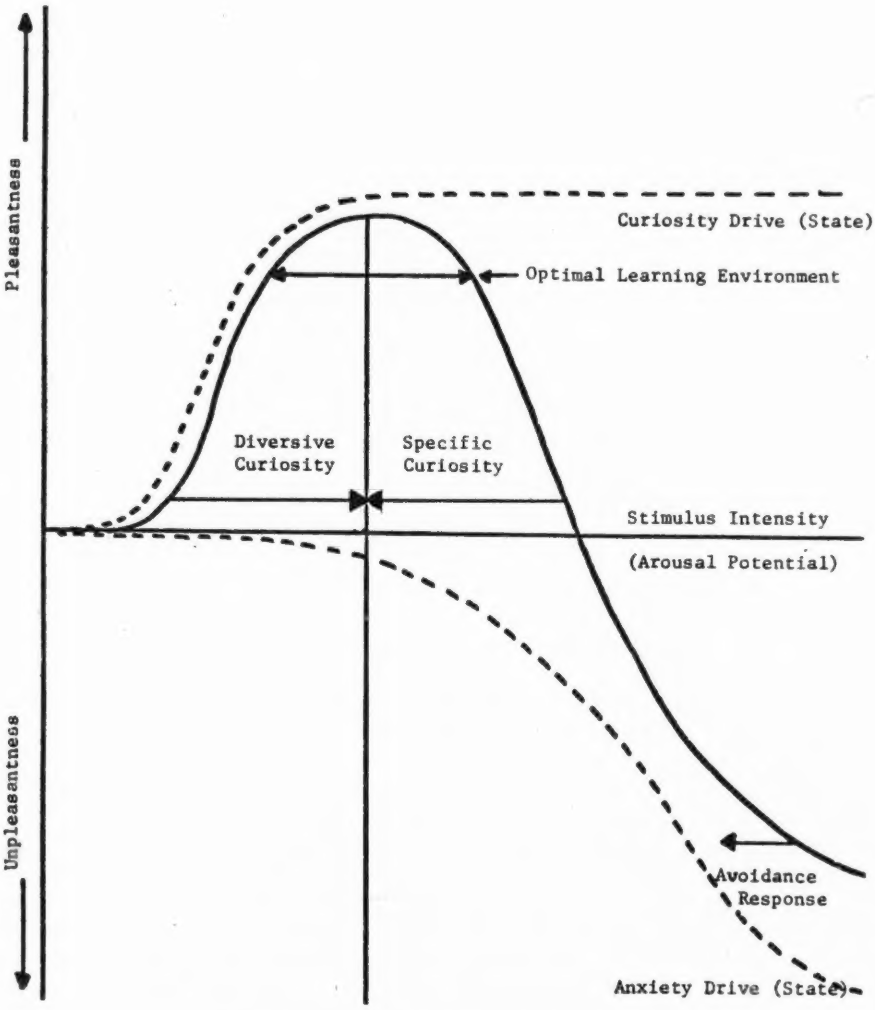

Pleasantness
Curiosity Drive (State)
Optimal Learning Environment
Diversive Curiosity
Specific Curiosity
Stimulus Intensity
(Arousal Potential)
Unpleasantness
Avoidance Response
Anxiety Drive (State)

Figure 2.—The optimal degree of arousal model

motivational aspects of the positive effects of epistemic curiosity can, therefore, be seen to result from positive feelings or experiences with a stimulus situation involving symbolic processes. Conversely, the posited relationship between states of anxiety and states of curiosity implies that high levels of anxiety can interfere with the attainment of an optimal degree of arousal (i.e., curiosity).

It is important to note the essential differences between Day's (1967, 1969c) position regarding the relationship between curiosity and anxiety and the Spielberger and Butler (1971) position. First, Day (1967) has tended to restrict his conceptualization of curiosity to specific curiosity behaviors, and has argued that curiosity and anxiety states lie along the same arousal continuum. He further contends that curiosity and anxiety states are differentiated in terms of moderate or high levels of arousal, respectively. Thus, one basic mechanism underlying the arousal function is implied, and this theoretical position can be referred to as the One Factor Model.

On the other hand, however, Spielberger and Butler (1971) have argued for a Two Factor Model in which curiosity and anxiety are assumed to be separate drive systems that can co-exist phenomenologically and behaviorally under conditions of intermediate and high arousal. Within the Two Factor Model, curiosity drive is assumed to motivate diversive or stimulus-seeking curiosity behaviors and anxiety drive is assumed to motivate stimulus-avoidance behaviors. The further contention is made that specific curiosity is the behavior (not a drive) that results from the combination of diversive curiosity drive and anxiety drive (Spielberger & Butler, 1971). Berlyne (1967, 1971) has a theoretical position similar to Spielberger and Butler's (1971), in that degree of arousal increment (i.e., moderate to high increments) activates the separate reward and aversion systems which correspond to the drive states of curiosity and anxiety.

Differential predictions can be derived from the One and Two Factor Models, which can be tested empirically. The predictions possible from the One Factor Model include:

1. On the assumption that state specific curiosity scales are measuring intermediate levels of arousal, whereas state anxiety scales are measuring high levels of arousal, an inverse relationship would be predicted between specific curiosity and anxiety.
2. On the assumption that the arousal continuum for state specific curiosity and state anxiety ranges from moderate to high levels of arousal, respectively, the possible combinations of curiosity-anxiety states on this arousal continuum are ordered from low state anxiety/low state curiosity to low state anxiety/high state curiosity to high state anxiety/low state curiosity to high state anxiety/high state curiosity.
3. Given the inverse relationship predicted between state curiosity and state anxiety, relatively few persons in the categories of (a) low state anxiety/low state curiosity, and (b) high state anxiety/high state curiosity would be expected.
4. On the assumption that high arousal levels are associated with debilitating and unpleasant feeling states (i.e., anxiety), and intermediate arousal levels are associated with facilitating and pleasant feeling states (i.e., specific curiosity), inferior performance would be predicted for persons with highest arousal levels (i.e., high state anxiety/high state curiosity) and superior or optimal performance would be predicted for persons with intermediate arousal levels (i.e., low state anxiety/high state curiosity).

The differential predictions possible from the Two Factor Model include:

1. On the assumption that state diversive curiosity scales are measuring intermediate levels of arousal, whereas state specific scales and state anxiety scales are measuring high levels of arousal, the inverse relationship between curiosity and anxiety would be more pronounced for diversive rather than specific curiosity.
2. On the assumption that at moderate and high levels of stimulus intensity both state diversive curiosity and state anxiety exist at high levels of arousal, only three

possible combinations of curiosity-anxiety states are located along the arousal potential continuum. These combinations are ordered from low state anxiety/low state curiosity to low state anxiety/high state curiosity to high state anxiety/high state curiosity.

3. Given the combinations of state curiosity and state anxiety which lie along the arousal potential continuum, relatively few persons in the category of high state anxiety/low state specific curiosity would be expected.

4. On the assumption that high arousal states of anxiety are debilitating to optimal performance, whereas high arousal states of specific curiosity facilitate optimal performance, superior performance would be expected for persons in the category of high state anxiety/high state specific curiosity relative to other possible categories within this model.

It may be possible to derive other theoretical models which fit the Optimal Degree of Arousal concept, as well as concomitant differential predictions. For the purposes of the present investigation, empirical tests will be restricted to the predictions derived from the One Factor and Two Factor Models. On the basis of the data collected, however, suggested alternatives or extensions of these models will be advanced where appropriate. Relevant to a discussion of optimal degrees of arousal is the evidence on the relationship between curiosity and anxiety; thus, the following section will review empirical evidence in support of this theoretical relationship.

Evidence of the Relationship Between Curiosity and Anxiety

Indirect evidence of the relationship between curiosity and anxiety comes from the writings of Maslow (1963). He postulates the existence of an innate need to explore, manipulate, and know in humans which is antithetical to anxiety, or fear of the unknown. The evidence which Maslow (1963) presents in support of his position includes: (a) clinical data which indicate that psychologically healthy people are positively attracted to the unknown or unexplained, in contrast to a fear of the unknown in psychologically unhealthy people; (b) instances in which lack of curiosity and interest in their environment leads to pathology in children; (c) the fact that therapy is successful because of the individual's need to know and grow; and (d) findings which indicate that innate systems can atrophy or die through disuse and that "Curiosity can die through lack of use, or through being forbidden" (Maslow, 1963, p. 119).

Further explications by Maslow (1963) of the complex relationship between anxiety and curiosity include the recognition that anxiety can kill curiosity or exploration, in that knowledge and understanding are used only for the purpose of allaying anxiety. In addition, he feels that the absence of curiosity can be an active or passive expression of anxiety. Thus, anxiety and curiosity are seen as mutually incompatible, and one of the goals of education must certainly be to avoid the detrimental effects of anxiety by promoting the facilitating effects of curiosity behaviors–particularly those epistemic behaviors which reflect man's need to know. As Maslow (1963, p. 125) states, "It seems also quite clear that this need to know, if we are to understand it well, must be integrated with fear of knowing, with anxiety, with needs for safety and security."

Another source of indirect evidence concerning the relationship between curiosity and anxiety is found in the developmental theory of Jean Piaget. In essence, Piaget's (1930, 1954, 1968) theory holds that dynamic cognitive growth results from the interaction of the child with his environment, in that he develops certain logical convictions which must undergo transformations or adaptations with repeated encounters with that environment. The dynamic nature of this growth is due in large part to the association between structural and emotional changes which produce a heightened sensitivity to inconsistencies or deviations within the child's logical system. Lack of balance, or disequilibrium, between existing cognitive structures and new sources of information constitutes the dynamic growth principle which forms the basis for Piaget's theory of motivation; the human organism is held to have a basic need to continue contact with his environment as long as the adaptation process is incomplete.

Reiss (1968) suggests that there is a need to integrate Piaget's work with motivational theory, as a means for understanding the relationships between the processes of affect and the processes of acquiring knowledge. For Piaget, an optimal level of discrepancy or incongruity exists at each stage of development and the organism "is concerned with those things which lie just beyond his intellectual grasp--far enough away to present a novelty to be assimilated, but not so far but what accommodation is possible" (Tuddenham, 1966, p. 214). In the area of affect, Piaget (1968) recognizes that first fears can be related to loss of equilibrium or the inability of the organism to accommodate to incongruities in environmental stimulation. Therefore, environmental incongruities must be within the individual's capacity for accommodation, i.e., limited or moderate incongruities are considered to facilitate growth, whereas large incongruities instigate withdrawal, fear, or anxiety.

More direct experimental evidence bearing on the relationships between curiosity, anxiety, and arousal is discussed by Day (1969a). Research evidence is cited which indicates that objectively identical stimulation will affect an individual's direction of attention and level of curiosity dependent on his level of anxiety. According to Day (1969a), the amount of arousal increment may be sufficient to determine whether the direction of an individual's behavior will be anxiety or curiosity; and, thus, these two phenomena may be distinguished by their locations on the arousal continuum. Evidence is reported that when an individual is already in a curiosity state, increasing his uncertainty can result in his entering an anxiety state.

Both Day (1967) and Lester (1968) review empirical evidence on the relationship between anxiety and curiosity. Day (1967) cites evidence which supports the optimal degree of arousal concept, in that small increments of arousal are pleasurable, whereas large differences lead to unpleasant feeling states. Specifically, he presents evidence that subjects prefer more arousing (interesting) stimulus conditions to less arousing (pleasant) stimulus conditions, whereas high arousing stimulus conditions lead to feelings of anxiety. In addition, results of investigations by Day (1967) indicated that high anxious subjects decreased their exploration of complex stimuli under conditions of increased arousal (loud blasts of white noise), whereas low anxious subjects increased their exploration under these high arousal conditions.

The conclusions Lester (1968) draws from his review of the effects of fear and anxiety on exploration also support the existence of a negative or inverse relationship between anxiety and curiosity. For example, Lester (1968) presents evidence that when a subject's anxiety level is high, the presentation of novel stimuli is more apt to arouse an anxiety response than when anxiety level is low; and further, that a rise in anxiety (arousal) level causes an increase in curiosity in low anxious subjects and a decrease in curiosity in high anxious subjects. Two postulates which Lester (1968, p. 117) derives from research evidence on the relationship between curiosity and anxiety are:

1. "At any given time, an organism has a need for a given rate of stimulation. When the level of stimulation is less than this needed amount the organism will behave so as to increase the level of stimulation (that is, explore). When the level of stimulation is greater than the required amount the organism will behave so as to reduce the level of stimulation."

2. "The level of arousal produced by a stimulus incident upon an organism is related to the latency of the exploratory response of the organism to the stimulus by a U-shaped function. Response latency is at a minimum at intermediate levels of arousal."

These postulates support the Optimal Degree of Arousal Model and add to the testable predictions from such a model.

Additional evidence in support of the inverse relationship between curiosity and anxiety is found in an investigation by Penney (1965). In a comparison of both trait curiosity and trait anxiety in children, high anxious children were found to inhibit exploratory behavior, whereas the reverse was true of low anxious children. Trait curiosity was measured by the Children's Reactive Curiosity Scale (Penney & McCann, 1964), which examined whether a child was prone to seek stimulus variety in different situations or prone to explore novel objects. Although such a measure seems to be tapping diversive or perceptual curiosity behaviors, as defined earlier, the results of Penney's (1965) study are suggestive of the relationship between epistemic curiosity and anxiety.

Two tangentially related studies are those of Munz and Smouse (1968) and Sweeney, Smouse, Rupiper and Munz (1970), both of which attempt to relate the inverted-U hypothesis to item-difficulty, achievement anxiety, and academic test performance. In general, the results of these studies indicated that an inverted-U hypothesis could be used to explain the finding that item sequences are progressively more arousing in the order of random, easy to hard, and hard to easy. The Alpert-Haber Facilitating and Debilitating Anxiety Scales (Alpert & Haber, 1960) were used, and another finding of interest was that subjects scoring high on the debilitating scale performed better under low arousal than normal and high arousal, whereas subjects scoring high on the facilitating scale performed best under normal arousal conditions. If it can be assumed that facilitating anxiety is related to curiosity behaviors, these results are supportive of the Optimal Degree of Arousal concept which holds that performance is best under moderate degrees of arousal.

In summary, the research evidence reviewed in the previous sections seems to indicate that (a) hedonic value (pleasant versus unpleasant feeling states) are related to curiosity behaviors by an inverted-U function; (b) curiosity appears to be related to an intermediate or optimal level of arousal, whereas anxiety appears to be related to a higher level of arousal; (c) less increments in degree of arousal disrupt the performance of high anxious students relative to low anxious students; and (d) the performance of students appears to be best under moderate or optimal levals of arousal (curiosity) than higher levels of arousal (anxiety). Thus, these results seem to support the general predictions derived from the Optimal Degree of Arousal Model.

On the basis of the interactive relationship which has been found between curiosity and anxiety, it seems reasonable to suggest that one means for reducing the disruptive effects of state anxiety on learning and performance may be to stimulate state curiosity to an optimal level of arousal. This suggestion implies the need to take into account individual differences in both trait curiosity and trait anxiety, and the need for empirically sound measures of both trait and state curiosity and trait and state anxiety. A reliable and valid measure of trait and state anxiety, the State-Trait Anxiety Inventory, has been developed by Spielberger et al. (1970). In addition, progress has been made in the development of a measure of trait curiosity, the Ontario Test of Intrinsic Motivation, by Day (1969c, 1969b). This latter measure and other trait measures of curiosity behaviors will be discussed in the following section, after which a section will be devoted to discussing the development of a measure of state epistemic curiosity (Leherissey, 1971b).

Trait Measures of Curiosity

An area which has received recent research attention is the attempt to develop measures of both diversive and specific curiosity. One of the major investigators of specific curiosity measures is Day (1968, 1969b, 1969c), who has argued that most previous measures of curiosity (e.g., Penney & McCann, 1964; Maw & Maw, 1961) have not clearly distinguished between diversive and specific curiosity in their definitions of the curiosity concept, leading to difficulties in interpreting the results of curiosity studies. Although Day (1969c) distinguishes between curiosity as a personality trait and as a transitory state, he has concentrated his efforts on developing a trait measure of specific curiosity which he calls the Ontario Test of Intrinsic Motivation (OTIM).

In two papers, Day (1969b, 1969c) describes his rationale, procedure, validity and reliability data on the OTIM. Following Berlyne's theoretical position regarding the concept of specific curiosity, Day (1969c, p. 12) outlines four criteria differentiating individuals on the basis of whether they (a) show approach behavior in the presence of novelty, complexity, and/or ambiguity; (b) show some form of exploration in the presence of novelty, complexity and/or ambiguity, by attending to it, manipulating it, handling it, etc; (c) investigate novel, complex and/or ambiguous stimuli by asking questions, and/or consulting sources of information which would tell them more about them; and (d) explore novel, complex, and/or ambiguous stimuli longer than familiar, simple and/or clear stimuli.

The OTIM measures three dimensions: (a) interest specificity (outdoors, mechanical, computation, scientific, persuasive, artistic, literary, musical, social service, clerical); (b) stimulus properties (novelty, ambiguity, complexity); and (c) response types (consultation, observation, thinking). In addition, the OTIM contains 10 Social Desirability items. Although the OTIM is a relatively new measure and little reliability and validity data are available, it seems to represent an outstanding effort to develop a theoretically-derived trait measure of specific curiosity.

In the area of diversive curiosity measures, Zuckerman, Kolin, Price and Zoob (1964) report the development of a Sensation Seeking Scale (SSS) based on the concept of an optimal level of stimulation, excitation or activation. As part of the developmental efforts, Zuckerman et al. (1964) correlated scores on the SSS with anxiety, as measured by the Zuckerman Multiple Affect Adjective Checklist (general form), and found a significant negative correlation. This relationship is in the predicted direction, on the assumption that curiosity and anxiety are inversely related drives.

Zuckerman and Link (1968) report construct validity data for the SSS. The SSS was correlated with the Edwards Personal Preference Scale (PPS), the MMPI, Eysenck Personality Inventory (EPI), Adjective Check List (ACL), and Embedded Figures Test (EFT). Major findings were positive correlations of the SSS with autonomy, change, exhibitionism as measured by the PPS and ACL, whereas PPS and ACL deference, nurturance, orderliness, and affiliation scores yielded negative correlations with the SSS. The SSS also correlated positively with Hypomania on the MMPI and Lability on the ACL, and negatively with Self-Control on the ACL and Field Dependency on the EFT.

In addition, factor analysis identified four factors in males (Thrill Sensation Seeking, Social Sensation Seeking, Visual Sensation Seeking, and Antisocial Sensation Seeking), whereas only the first two of these factors were identified in females (Zuckerman & Link, 1968). Later factor analytic work by Zuckerman, Neary, and Brustman (1970) identified four interpretable factors for both sexes: Thrill and Adventure Seeking, Experience Seeking, Disinhibition, and Boredom Susceptibility. Thus, the SSS appears to be a good trait measure of diversive curiosity and one which could be used in the empirical investigation of the relationships between curiosity behaviors predicted by the Optimal Degree of Arousal Model.

To date, no research instrument has been developed to measure curiosity states, particularly as these relate to the learning process. In order to investigate the relationships between state curiosity, state anxiety, and performance, a measure of state epistemic curiosity was developed by the investigator (Leherissey, 1971b). The following section summarizes the rationale, conceptualization, scale construction, reliability and validity data collected in two studies using this State Epistemic Curiosity Scale (SECS).

Development of a Measure of State Epistemic Curiosity

The class of curiosity behaviors most relevant to the learning process are those epistemic or knowledge-seeking behaviors which lead to the permanent storage of information (Berlyne, 1971). The state of epistemic curiosity was conceptualized as a transitory motivational condition of the student, the arousal level of which was expected to vary across time, both with the nature of the specific learning task and the student's personality characteristics or predispositions. Thus, dependent upon the student's level of trait epistemic curiosity (i.e., relatively stable tendency to engage in specific knowledge-seeking behaviors under conditions of conceptual conflict) and past experiences with specific types of learning tasks, he would be expected to exhibit differential levels of state epistemic curiosity across time.

In general, an individual with a high level of trait curiosity would be expected to respond with higher levels of state curiosity more frequently in specific learning situations than an individual with a low level of trait curiosity. Individuals high in trait curiosity would also be expected to respond to conceptual conflict with increased state epistemic curiosity intensity in specific learning tasks perceived as within the optimal adaptation range, i.e., a situation which produces a conflict that the individual feels he can master or solve. In addition, it would be expected that individuals with a high level of state epistemic curiosity in a specific learning situation would perform better than individuals with a low level of state epistemic curiosity.

On the basis of the Optimal Degree of Arousal Model (see Figure 2), the state of epistemic curiosity was assumed to be characterized by a moderate or optimal degree of tension, excitement or arousal, associated with pleasant hedonic feelings and approach behaviors toward a novel or unfamiliar learning task. Pleasant hedonic feelings were assumed to be related to whether a student felt the learning materials were "interesting," "fun," "exciting," and/or "fascinating." State epistemic curiosity behaviors were further assumed to be related to a student's desire to: (a) know more about a learning task, (b) approach a novel or unfamiliar learning task, (c) approach a complex or ambiguous learning task, and (d) persist in information-seeking behavior in a learning task (Leherissey, 1971b). These four criteria provided the rationale for item construction on the SCS.

The 20-item SECS was developed primarily as a research instrument for investigating the relationships between state epistemic curiosity, state anxiety, and performance in a learning task. The steps in the development of the SECS and the procedures used to construct items included: (a) several items on the OTIM (Day, 1969a) which had face validity for the concept of epistemic curiosity were rewritten so as to retain the psychological content of the item, but altered in content and form so that the item could be used with state instructions toward the learning materials; and (b) the remaining items were constructed by the author to reflect the four criteria outlined in the previous paragraph. From an empirical viewpoint, the 20-item SECS was administered to students in two studies for the purpose of collecting reliability and validity data on this scale, and to further explicate predicted relationships between state epistemic curiosity, state anxiety, and performance.

In the first study (Leherissey, O'Neil, Heinrich, & Hansen, 1971b), state epistemic curiosity was measured in response to a Computer-Assisted Learning (CAI) experiment. The subjects were 128 female undergraduates, randomly assigned to four learning program versions on the basis of their level of A-Trait (low, medium, high). The basic learning program was the same as that described by Leherissey, O'Neil, and Hansen (1971a), and dealt with familiar and technical materials on heart disease. The four program versions were: reading–long (R–L), reading–short (R–S), constructed response–long (CR–L), and constructed response–short (CR–S). State epistemic curiosity toward the learning materials was measured by the SECS, specific trait curiosity was measured by the OTIM, and state and trait anxiety were measured by the STAI. Student performance was assessed by an achievement posttest covering the familiar and technical learning materials.

The reliability data collected in Study I indicated that the 20-item SECS had an alpha reliability coefficient of .82. (See Appendix A for the original version of the SCS.) Dropping items with item-remainder correlations of less than .30 resulted in a 16-item scale with an alpha reliability coefficient of .87. In addition, partial evidence of the construct validity of the SECS was provided by the correlations between the SCS and OTIM. The SECS was found to have a moderately high positive correlation with the total OTIM scale ($r = .43$, $p < .05$ for the 16-item scale), which provided some indirect evidence that the SECS was measuring specific curiosity. Students with high trait curiosity, as measured by the OTIM, were also found to have higher state epistemic curiosity scores than medium or low trait curiosity students ($F=14.15$, $df=2/116$, $p < .001$). An interesting finding was that students in the CR groups tended to have lower state curiosity scores ($F=3.76$, $df=1/116$, $p < .10$) than students in the R groups.

Evidence of the construct validity of the SECS was also provided by correlations between the SECS, STAI A-Trait, and STAI A-State scales. In general, results of this correlational analysis supported the relationships predicted by the Optimal Degree of Arousal Concept in that (a) all correlations between the SECS and STAI A-State scales given during the experimental task were in the predicted direction, i.e., state curiosity and state anxiety were found to be inversely related; and (b) the strongest negative correlations between state curiosity and state anxiety were found on the more difficult portions of the CAI learning task ($r = -.36$, $p < .01$) and posttest ($r = -.22$, $p < .05$), whereas there was no significant relationship between these variables on the pretest ($r = -.06$) and pretask ($r = -.15$) measures. Significant correlations were not found between the SECS, A-Trait and OTIM scales, which indicated that (a) the predisposition (A-Trait) to manifest a state of anxiety was not related to state curiosity, and (b) the predisposition to manifest states of anxiety was not related to predispositions to manifest states of curiosity.

As further evidence of the construct validity of the SECS, correlations were computed between the SECS and achievement measures given during the CAI learning experiment. State epistemic curiosity was assumed to relate positively with facilitated performance; and, thus, it was expected that students scoring high on the SECS would make more correct responses on the achievement measures than students scoring low on the SECS. Significant positive correlations between the SECS and posttest achievement measures were found ($r = .41$, $p < .01$), indicating that high state curious students tended to perform better than low state curious students, particularly on the more difficult technical portions of the posttest.

Additional reliability and validity data for the SECS was obtained in a second study in which the SECS, Zuckerman Sensation Seeking Scale (SSS; Zuckerman, Kolin, Price, & Zoob, 1964), STAI A-Trait and A-State scales were administered in class to 40 female undergraduate volunteers enrolled in a health education course. Since the SSS was considered to be a measure of diversive curiosity, low positive correlations between the SECS and SSS were expected. The subjects were instructed to respond to the SECS and STAI A-State scales with how they felt while learning the course material; they were instructed to respond with how they felt in general on the SSS and STAI A-Trait scales. The four items on the SECS which had been dropped from the 20-item scale used in Study I were rewritten to bring the total number of items to 20. (See Appendix A for the revised scale used in Study II.)

The alpha reliability coefficient of the SECS used in Study II was found to be .89, with all but one of the revised items having item-remainder correlations of more than .30. An indirect test of the assumption that the concept of state epistemic curiosity was distinct from that of diversive or stimulation-seeking curiosity was provided by the correlations between SECS and SSS. As expected, the SSS was not found to correlate significantly with the SECS (r = .17). The expected inverse relationship between A-State and the SECS was found, although this correlation did not approach significance (r = –.12). Caution should be taken in interpreting these correlations, however, due to the fact that the sample size used was small, and the fact that responses to the SECS and SSS reflected feelings toward the course materials as a whole. Thus, it is possible that more generalized states of curiosity and anxiety toward course material were being measured, which may have accounted for the failure to find a significant negative correlation between these variables. The present study, therefore, sought, in part, to specify the precise relationships between states of epistemic curiosity and states of anxiety aroused in a CAI learning task by taking periodic measurements of both state curiosity and state anxiety.

More importantly, however, the present study focused on empirically validating predictions derived from the Optimal Degree of Arousal conceptualizations, particularly as these relate to an optimal learning environment. Specification of the relationships between learner characteristics (i.e., changes in state curiosity and state anxiety) and situational variables (i.e., stimulating curiosity in a complex CAI learning task) should allow for more precise statements concerning the variables important for optimal learning. The experimental manipulation of curiosity to enhance the learning process is at present an unexplored area of investigation, but one which appears to offer promising results. The present study represented a pioneering effort in this direction. Also of an exploratory nature was the collection of curiosity, anxiety, and performance data which allows an empirical test of the differential predictions derived from the One Factor Model and Two Factor Model versions of the Optimal Degree of Arousal Model.

Statement of the Problem

The purpose of this study was to investigate the effects of stimulating state epistemic curiosity on the state anxiety and performance of students differing in level of trait curiosity and trait anxiety (high, low) in two CAI response mode conditions (reading, constructed response). Curiosity was stimulated by means of a written passage designed to increase state curiosity, designated as the Curiosity-Stimulating Condition (CSI). Since no experimental literature exists on effective means for stimulating curiosity in an instructional setting, a conceptual approach based upon the essential qualities of epistemic curiosity was used. Thus, the criteria for writing the curiosity-stimulating instructions were the four points outline in the section on the development of the SECS. In addition, these instructions were written to enhance hedonic feelings, e.g., interest, excitement. Students in the No Instructions (NI) condition did not receive the curiosity-stimulating instructions. All students were presented a complex CAI learning task dealing with technical materials on the diagnosis of myocardial infarction, described by Leherissey, O'Neil, and Hansen (1971a).

In two previous CAI studies with these learning materials (Leherissey, O'Neil, & Hansen, 1971a; Leherissey, O'Neil, Heinrich, & Hansen, 1971b), it was found that subjects in the constructed response (CR) group had higher levels of state anxiety during the technical portions of the learning materials and posttest than subjects in the reading (R) group. However, no differences in A-State for these groups were noted on the familiar portions of the learning materials and posttest. Since the major effects of state anxiety were found on the technical materials, the present study used only the technical portions of the learning materials and posttest.

Students were matched for this study on the basis of extreme scores on the OTIM and STAI A-Trait scale. The OTIM was used to measure trait curiosity; the STAI was used to measure both A-Trait and A-State; the SECS was used to measure state curiosity. Both state curiosity and A-State were measured periodically throughout the experimental task in order to more precisely define the relationship between curiosity and anxiety, as well as to investigate the effects of stimulating curiosity on state anxiety and performance.

Another purpose of this study was to further validate the State Epistemic Curiosity Scale (SECS) and investigate the relationships between trait and state curiosity and trait and state anxiety as these relate to the Optimal Degree of Arousal Model. To this end, the Ontario Test of Intrinsic Motivation (OTIM) was administered and subjects were classified according to their level of specific trait curiosity (low, high). In addition, a measure of diversive trait curiosity, the Sensation Seeking Scale (SSS), was administered and correlated with the SECS and OTIM to provide an indirect test of construct validity.

On the basis of the pilot study findings with the SECS and predictions derived from the Optimal Degree of Arousal Model, the following hypotheses were made:

1. High trait curious students will have higher levels of state curiosity throughout the experimental task than low trait curious students.
2. Levels of state curiosity will change over time, i.e., students' levels of state curiosity will change across the six in-task measurement periods, as well as pre and post experimental session.
3. High state curious students will have lower levels of state anxiety throughout the experimental task than low state curious students.
4. High state curious students will make more correct responses on the achievement measures than low state curious students.
5. Students in the Curiosity-Stimulating Instructions group will have higher levels of state curiosity than students in the No Instructions group.

The following hypotheses are derived from Trait-State Anxiety Theory (Spielberger, 1966; Spielberger et al., 1970) and previous research:

1. High A-Trait students will have higher levels of A-State throughout the experimental task than low A-Trait students.
2. Levels of A-State will change over time, i.e., students' levels of state anxiety will change across the six in-task measurement periods, as well as on the pre measure and after the posttest.
3. Low A-State students will make more correct responses on the achievement measures than high A-State students.

Because of the infancy of the SECS and the new formulation of the Optimal Degree of Arousal Model, it would be premature to make second and third order interaction hypotheses.

II. METHOD AND PROCEDURES

This study investigated the effects of stimulating state epistemic curiosity on level of state anxiety and performance in a complex CAI learning task for college students differing in level of trait curiosity and trait anxiety, and response mode condition. In addition, a primary focus of this study was the further validation of the State Epistemic Curiosity Scale (SECS) developed by Leherissey (1971b), and an integration of present findings within the Optimal Degree of Arousal Model predictions. Subjects who were low and high in trait curiosity and trait anxiety were matched and assigned to curiosity-stimulating instruction or no instruction conditions within reading or constructed response mode conditions. The major dependent variables were state curiosity, state anxiety, and correct responses on the achievement posttest.

Curiosity Measures

The Ontario Test of Intrinsic Motivation (OTIM) developed by Day (1969b) was used to match Ss on a trait measure of specific curiosity. The 110-item OTIM was administered in an initial group testing session with instructions for Ss to "indicate how they generally feel." In addition, the response format of the OTIM was altered from a true/false format to include the response categories of the STAI A-Trait scale, i.e., (a) Almost never, (b) Sometimes, (c) Often, and (d) Almost always.

The Sensation Seeking Scale (SSS) developed by Zuckerman, Kolin, Price and Zoob (1964) was used as a trait measure of diversive curiosity. Since the SSS contains items which load differentially for males and females and the subjects to be used in this study consisted of undergraduate females only, just those items of the SSS applicable to females were administered. In addition, one of these items which deals with a currently controversial issue (i.e., the S's willingness to try hallucinatory drugs) was dropped, thus leaving a total of 29 items. The SSS was administered in the initial group testing session with instructions for Ss to "indicate how they generally feel" in a binary forced-choice response format.

The revised 20-item State Epistemic Curiosity Scale (SECS) developed by Leherissey (1971b) was administered in the group testing session (see Appendix B for Form A of the SECS), with instructions, "indicate how you think you would feel while learning new materials." The short form SECS, which consisted of those five items having the highest item-remainder correlations with the samples used in Studies I and II and two additional context specific items, were presented in random order before or after the short form A-State scales. The individual items on the short SECS scales were also randomly ordered (see Appendix B for Form C of the SECS) between presentations and the short form SECS scales were administered a total of six times during the experimental session. The short form SECS scales were given immediately after the introduction to the learning materials, after the curiosity-stimulating or no instruction conditions, after the first and second half of the initial technical (T_I) learning materials, and after the first and second half of the remaining technical (T_R) learning materials via CAI. The SECS scales administered in the group testing session, before and after the curiosity-stimulating or no instruction conditions, were presented with instructions for Ss to "indicate how you feel right now." The remaining short form SECS scales were administered with retrospective state instructions, i.e., "indicate how you felt during the task you have just finished." The 20-item SECS, given after the achievement posttest, was presented with instructions "indicate how you felt while you were learning the instructional materials." (See Appendix B for Form B of the SECS.)

Anxiety Measures

The State-Trait Anxiety Inventory (STAI) developed by Spielberger, Gorsuch, and Lushene (1970) was used to measure both trait and state anxiety. The STAI A-Trait scale was used to match Ss with low and high levels of A-Trait. The 20-item A-Trait scale was administered in the group testing session with standard trait instructions, i.e., "indicate how you generally feel." The 20-item A-State scale was also administered in the group testing session with the instructions, "indicate how you think you would feel while learning new materials." The short form of the STAI scale, which consists of those five items having the highest item-remainder correlations with the normative sample of the 20-item A-State scale, was administered a total of seven times during the experimental session. The short form A-State scales were presented at the same points in the CAI task as the short form SECS scales; and, in addition, was administered after the achievement posttest via paper and pencil. As with the short form SECS scales, each of the presentations of the short form A-State scale had randomly order item presentation from scale to scale.

Selection of Subjects

The STAI A-Trait and A-State scales, the SECS, OTIM, and SSS were administered to 222 female undergraduate students enrolled in psychology and education classes at Florida State University in the Spring Quarter, 1971. The testing sessions were conducted either in class or in special group-testing sessions. Those females who participated in the testing sessions were paid $2.00. From this population, females whose STAI A-Trait scores were in the upper and lower 30 percent of the normative A-Trait distribution for college undergraduate females (Spielberger et al., 1970) were matched for extreme scores on the OTIM; and were designated as low A-Trait/low trait curiosity, low A-Trait/high trait curiosity, high A-Trait/low trait curiosity, and high A-Trait/high trait curiosity groups, respectively.

The A-Trait cut-off scores for low A-Trait students were 34 or below; the A-Trait cut-off scores for high A-Trait students were 41 or above. The OTIM scores were ranked and split at the median; students in the extreme A-Trait groups were then matched with low and high trait curiosity scores. The low OTIM scores were 290 and below; the high OTIM scores were 291 and above. The students who were matched on level of trait curiosity and level of trait anxiety were asked to participate in an experiment on computer-assisted learning, and were told they would be paid approximately $2.00 an hour, or a total of $4.00 for participating in the CAI experiment.

A total of 152 students were run in small groups of 8 to 12 in a total of 13 experimental sessions. Each group was processed by 2 to 4 male and/or female experimentors. The students were assigned to response mode and instruction conditions in a manner such that the mean OTIM and A-Trait scores were comparable across experimental conditions. The means and standard deviations of OTIM and A-Trait scores for students in response mode and instruction conditions indicated that students were well-matched on trait curiosity and trait anxiety scores (see Appendix E). Twenty-one students were dropped from the original group selected to equalize cell means and frequencies; five students were eliminated because of missing data.

Apparatus

An IBM 1500 system (IBM, 1967) was used to present the learning materials. Terminals for this system consist of a cathode ray tube (CRT), a light pen, and a typewriter keyboard. The terminals are located in a sound-deadened, air-conditioned room. The SECS state curiosity scales and the STAI A-State scales were presented on the CAI system in order to measure state curiosity and A-State while Ss worked through the learning materials. The CAI system recorded all S responses, including response latencies.

Learning Materials and Program Description

The technical portion of the instructional program described by Leherissey, O'Neil, and Hansen (1971a), entitled, *Diagnosis of Myocardial Infarction*, was presented via CAI. The learning materials and posttest were divided into two sections: (a) Initial Technical (T_I) materials; and (b) Remaining Technical (T_R) materials. The 89 frames of technical materials dealt with the diagnosis of myocardial infarction, types of damage to the heart muscle, associated electrocardiogram (EKG) tracings, and the stages in the healing process. Both verbal and graphical (e.g., EKG drawings and tracings) frames were included in the technical materials. An example of the T_I and T_R materials is given in Appendix C.

The basic learning program was divided into two versions, each containing exactly the same subject matter and frame structure. These versions were: (a) Reading (R), to which Ss were not required to make any overt responses, but merely to read each frame successively. Response blanks were filled in and frames asking a question were presented in declarative form; (b) Constructed Response (CR) version, to which overt responses were required in the form of a typed word to response blanks on the verbal frames. On the graphical frames containing EKG drawing and tracings, Ss were required to "draw" EKG tracings before being shown the correct answer. The Ss constructed their graphic responses by special program coding which permitted them to construct successive parts of the drawings with various keyboard dictionary characters. Figure 3 illustrates how Ss in the CR group drew EKG tracings via CAI. For example, if the S was asked to draw the Normal EKG tracing, he referred to a handout of tracing segments (a), and chose the correct sequence of numbers which would construct this tracing (b). He then typed in these numbers one at a time and the normal EKG tracing appeared on the CRT (c). The special instructions and a further description of these program versions are given in the procedures section.

The R and CR program versions were modified for the curiosity-stimulating condition by the insertion of special curiosity-stimulating instructions (CSI Condition) following a brief introduction to the learning task. These instructions were pretested for effectiveness in raising level of state epistemic curiosity, as measured by the SECS, on a preliminary group of pilot Ss.

The curiosity-stimulating instructions were presented in three instructional frames which stated the following:

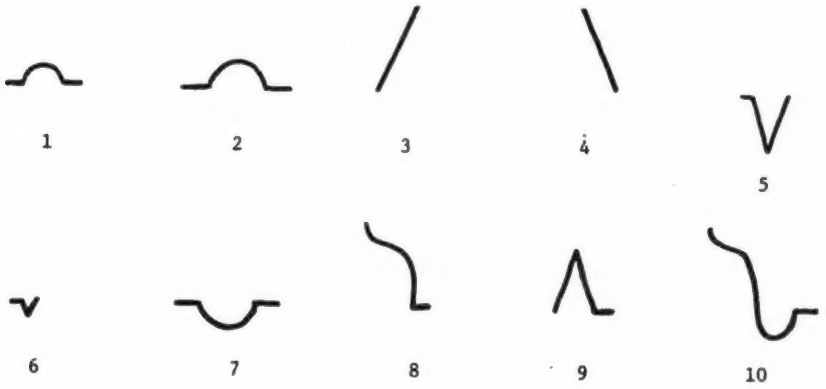
Frame 1

Did you know that --

> Heart damage causes more than half of all deaths in this country?
>
> Major types of heart damage can be identified by electrocardiogram tracings?

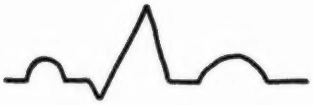
The stages of recovery from heart damage can be traced by an electocardiogram? Although you may know the general facts associated with the above statements, the precise medical knowledge concerning heart damage and its diagnosis is probably new to you.

A)



B) Correct sequence of numbers to "draw" Normal EKG tracing: 1, 6, 3, 4, 2

C)



Normal EKG Tracing

Figure 3.—Illustration of how students in CR versions "drew" EKG tracings via CAI.

Frame 2

For example, do you know --

1) the medical name for the heart muscle?

2) the medical names for the three major types of heart damage?

3) how an electrocardiogram tracing is obtained?

4) how heart damage is diagnosed by an electrocardiogram tracing?

5) how long it takes to recover from major heart damage?

Frame 3

The answers to those questions and many others are given in the instructional materials you are about to learn. For example, you will learn the medical terms for heart damage, how electrocardiogram tracings are recorded, how to differentiate between electrocardiogram tracings, and the stages in the healing process.

In the no instruction condition (NI), Ss were told to take a one-minute break, which was the length comparable to that of the curiosity-stimulating instructions. (Note: The experimental procedures and results of pilot testing the curiosity-stimulating instructions are described in Appendix D.)

Achievement Measures

The technical portion of the posttest used by Leherissey et al. (1971a) was administered to all Ss following their completion of the CAI instructional program. The technical posttest contained 13 items covering the verbal and graphical technical materials and required constructed responses. On the technical graphical items, Ss were required to draw EKG tracings by the same method used in the instructional program for the CR group, i.e., Ss were given a handout of tracing segments and were asked to choose the appropriate sequence of numbers to complete the required EKG tracings.

As a further index of the relationships between state curiosity, state anxiety, and student achievement, errors made on the instructional program by the CR group were analyzed. It will be recalled that the R group was not required to respond to the instructional program, and thus this achievement measure applied only to the CR group.

Procedure

The experimental session was divided into three periods: (a) a Pretask Period, during which Ss were assigned to response mode and instruction conditions, and read instructions on the operation of the CAI terminal; (b) a Performance Period, during which Ss received differential instructions (curiosity-stimulating instructions or no instructions), learned the technical CAI materials, and took the six short form state curiosity and state anxiety scales; and (c) a Posttask Period, during which Ss were administered the achievement posttest and its associated short form A-State scale, the 20-item SECS, and given a debriefing. Each of these periods is further described below. A time-line chart of the experimental procedures is shown in Figure 4.

Pretask Period. Upon arrival to the CAI Center, Ss were assigned to one of four experimental conditions based upon their level of trait curiosity and level of trait anxiety to insure an equal number of Ss in each group. These four conditions were: (a) Reading with Curiosity-Stimulating Instructions (R–CSI); (b) Reading without Curiosity-Stimulating Instructions (R–NI); (c) Constructed Response with

Curiosity-Stimulating Instructions (CR–CSI); and (d) Constructed Response without Curiosity-Stimulating Instructions (CR–NI). Following assignment to experimental treatments, Ss were asked to read written instructions on the operation of the CAI terminal.

Performance Period. All Ss were seated at CAI terminals and after "signing on", were presented short introductory materials on the general nature of the experimental task. The Ss were then presented the first short form state curiosity and state anxiety scales. Depending upon whether Ss were in the CSI or NI conditions, they received differential instructions, followed by the second combined state curiosity and state anxiety scales. The Ss were then presented with differential instructions as to how they should proceed through the learning task, depending upon whether they were in the R or CR response mode groups. All Ss were instructed to proceed through the materials at their own rate; specific instructions given to each response mode group were:

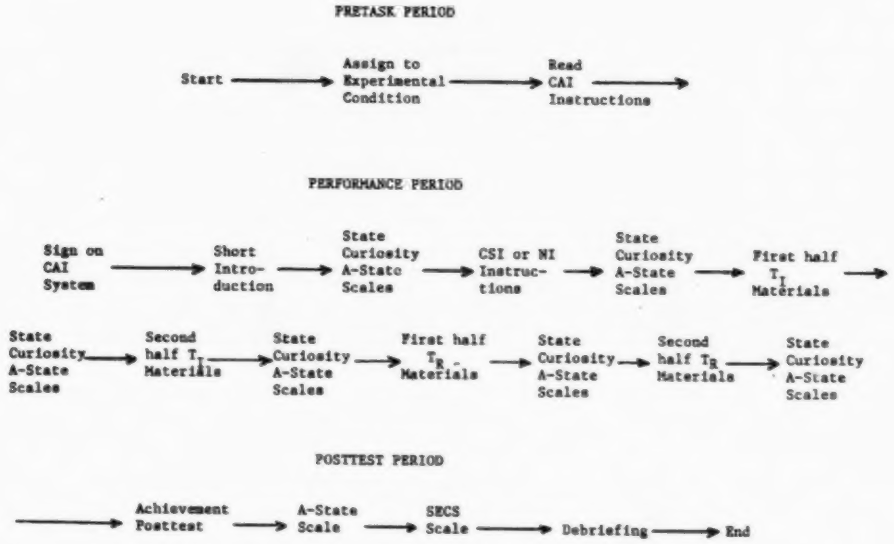

PRETASK PERIOD
Start
Assign to Experimental Condition
Read CAI Instructions
PERFORMANCE PERIOD
Sign on CAI System
Short Intro-duction
State Curiosity A-State Scales
CSI or NI Instruc-tions
State Curiosity A-State Scales
First half T_I Materials
State Curiosity A-State Scales
Second half T_I Materials
State Curiosity A-State Scales
First half T_R Materials
State Curiosity A-State Scales
Second half T_R Materials
State Curiosity A-State Scales
POSTTEST PERIOD
Achievement Posttest
A-State Scale
SECS Scale
Debriefing
End

Figure 4.–Experimental sequence of events in study.

1. **Reading:** "You will not be required to supply an answer to any of the frames. Simply press the space bar to continue on to the next frame. When you have finished the instructional material, you will be given a test on the material."

2. **Constructed Response:** "The material is presented in a series of frames, each of which requires you to give one or more answers. To answer each frame, you must type in the word or number that completes each blank and enter that response. On each frame of the

> material, when you have filled in all the blanks, the correct answer will appear on the screen before the next frame is presented. You will only be required to respond once to each frame, regardless of whether your answer is right or wrong. When you have finished the instructional material, you will receive a test on the material."

The CR group was given practice in the operation of the keyboard and on the enter and erase functions. On the technical graphical materials, the CR group was given a handout of 10 possible EKG tracing segments and instructed to type in the combination of numbers from 0-9 which would complete the appropriate tracing (see (a) in Figure 2). During this performance period, all Ss were presented the short form state curiosity and state anxiety scales with retrospective state instructions at four points in the instructional program: (a) following the first half of the T_I materials; (b) following the second half of the T_I materials; (c) following the first half of the T_R materials; and (d) following the second half of the T_R materials.

Posttask Period. After each S had completed the instructional program and final state curiosity and state anxiety scale, he was taken to another room and given a posttest package. Included in the posttest package was the technical portion of the posttest and a short form A-State scale with retrospective state instructions. In addition, all Ss were given a handout of the ten possible EKG tracing segments and instructed to use this handout when they were required to "draw" EKG tracings on the posttest. The Ss, therefore, chose the appropriate sequence of numbers to construct particular tracings, rather than actually drawing these tracings. After completion of the posttest package, Ss were asked to respond to the 20-item SECS. The Ss were then informed that the task was quite difficult and reassured that their performance was satisfactory. They were also given some additional information concerning the nature of the experiment and cautioned not to discuss the experiment with their classmates.

III. ANALYSIS OF DATA

The data analyses are categorized into the following three major sections: (a) Reliability and Validity of Personality Inventories; (b) Curiosity and Performance Results; and (c) Curiosity, Anxiety, and Performance Results. In the first section, the analyses are categorized into (a) reliability analyses on the SECS scales, OTIM scales, SSS scales, and STAI A-Trait and A-State scales; and (b) concurrent and construct validity of the SECS scales.

In the second section, the curiosity-performance outcomes are organized into (a) curiosity analyses; and (b) curiosity and performance analyses. These data analyses will investigate the hypothesized relationships between trait and state curiosity as well as the relationships between curiosity and performance as a function of trait and state curiosity levels, response modes, and instruction conditions.

In the third section, the analyses are subdivided into (a) anxiety analyses; (b) anxiety and performance analyses. Analyses in the fourth section are subdivided into (a) curiosity and anxiety analyses; (b) curiosity, anxiety, and performance analyses; and (c) an integration of curiosity, anxiety, and performance analyses within the Optimal Degree of Arousal conceptualizations. Within the third section, the reported analyses will examine the hypothesized relationships between trait and state anxiety, as well as the effects of response modes, instruction conditions, and levels of trait and state anxiety on posttest performance. The fourth section will investigate the relationships between curiosity and anxiety, for both traits and states, and will attempt to integrate the curiosity, anxiety, and performance results within the One Factor and Two Factor versions of the Optimal Degree of Arousal concept.

In addition, within sections two and three, the reported analyses will separately examine the effects of treatment variables, state epistemic curiosity, and/or state anxiety on (a) In-Task measures; and (b) Post-Task measures. The in-task measures will consist of those given during the CAI learning task; the post-task measures will be all scales given after the CAI learning task. The analyses which investigate whether students in response mode and instruction conditions are well-matched on the curiosity and anxiety measures administered prior to the experimental session are reported in Appendix E.

Of secondary subsidiary interest to the hypotheses investigated is the examination of treatment variables on total time spent on the CAI task, and the analyses which deal with replication of previous findings with these learning materials (Leherissey et al., 1971a; Leherissey et al., 1971b). These analyses may be found in Appendices F and G, respectively. Since only the Constructed Response groups responded to the CAI learning program, the analyses of the effects of instruction conditions on learning program performance are reported in Appendix H.

Reliability and Validity of Personality Inventories

State Epistemic Curiosity Scale Reliability

The means, standard deviations, and alpha reliability coefficients for the 20-item pre-task SECS, six short form in-task SECS, total in-task SECS, and 20-item post-task SECS measures are reported in Table 2.

TABLE 2

Means, Standard Deviations, and Alpha Reliabilities of
the Eight State Epistemic Curiosity Scales
Administered During Experiment (N=152)

Scale	Scale Range	Mean	SD	Alpha
Pre-task SECS	20-80	20.30	8.07	.88
First In-task SECS	7-28	24.21	3.13	.81
Second In-task SECS	7-28	24.20	3.60	.88
Third In-task SECS	7-28	24.41	3.76	.86
Fourth In-task SECS	7-28	22.31	4.96	.91
Fifth In-task SECS	7-28	22.49	5.02	.91
Sixth In-task SECS	7-28	20.30	5.82	.93
Total In-task SECS	42-168	138.39	21.24	.96
Post-task SECS	20-80	59.00	12.56	.94

As Table 2 indicates, the alpha reliabilities of the SECS scales ranged from a low of .81 to a high of .96, indicating high internal consistencies on both the short and long forms of the SECS scale.

Item-reminder correlations for the individual items on each SECS scale were calculated. Table 3 gives the means, standard deviations, and item-remainder correlations for individual items of the pre-task and post-task SECS scales. The means, standard deviations and item-remainder correlations for individual items on the six in-task SECS scales are reported in Table 4.

TABLE 3

Means, Standard Deviations, and Item-Remainder Correlations
for the Pretask and Posttask State Epistemic
Curiosity Scales (N=152)

	Pretask SECS			Posttask SECS		
Item	Mean	SD	Item Remainder	Mean	SD	Item Remainder
1	3.37	.63	.58	3.15	.81	.80
2	3.30	.71	.67	3.10	.85	.84
3	3.49	.60	.42	3.25	.82	.69

TABLE 3 (Continued)

	Pretask SECS			Posttask SECS		
Item	Mean	SD	Item Remainder	Mean	SD	Item Remainder
4	3.04	.76	.62	2.48	1.03	.71
5	3.06	.79	.28	3.21	.90	.62
6	3.41	.70	.62	3.02	.98	.87
7	3.18	.71	.47	2.71	1.08	.57
8	3.29	.72	.44	3.22	.80	.60
9	2.67	.70	.32	2.76	.93	.60
10	3.41	.64	.60	3.04	.83	.85
11	3.02	.79	.42	3.18	.83	.80
12	3.35	.69	.52	3.50	.75	.42
13	3.50	.69	.46	2.99	.99	.67
14	3.15	.83	.41	2.93	1.04	.32
15	3.00	.77	.41	2.99	.96	.62
16	3.19	.73	.56	2.34	.98	.64
17	2.73	.86	.50	2.41	1.01	.50
18	3.28	.71	.68	3.34	.79	.62
19	3.38	.67	.71	2.85	.99	.78
20	2.24	.92	.17	2.55	1.11	.49

For the data reported in Table 3, it should be noted that, with the exception of items 12, 13, and 18, the item-remainder correlations increased or remained the same from the pre-task to post-task SECS measures. Item-remainder correlations ranged from .30 to .87. As can be noted in Table 4, item-remainder correlations of the in-task SECS scales fluctuated depending on the measurement period in which the SECS scales were given.

TABLE 4

Means, Standard Deviations and Item-Remainder Correlations
for the Six In-Task State Epistemic
Curiosity Scales (N=152)

Scale	Item	Mean	SD	Item Remainder
First In-task SECS	1	3.60	.59	.43
	2	3.46	.62	.67
	3	3.32	.70	.57
	4	3.74	.52	.47
	5	3.42	.76	.65
	6	3.49	.66	.66
	7	3.19	.72	.37
Second In-task SECS	1	3.53	.64	.49
	2	3.53	.66	.68
	3	3.43	.66	.75
	4	3.68	.64	.65
	5	3.50	.69	.73
	6	3.17	.79	.58
	7	3.20	.88	.68
Third In-task SECS	1	3.41	.82	.30
	2	3.45	.72	.82
	3	3.33	.79	.78
	4	3.72	.54	.57
	5	3.37	.71	.79
	6	3.44	.76	.79
	7	3.68	.72	.43
Fourth In-task SECS	1	3.18	.87	.61
	2	3.18	.83	.82
	3	3.00	.92	.84
	4	3.39	.80	.69
	5	3.17	.86	.78
	6	3.19	.86	.81
	7	3.19	.96	.61
Fifth In-task SECS	1	3.31	.89	.64
	2	3.16	.95	.82
	3	3.14	.87	.87

(Table 4 Continued on next page.)

TABLE 4 (Continued)

Scale	Item	Mean	SD	Item Remainder
	4	3.44	.78	.71
	5	3.14	1.00	.85
	6	3.13	.91	.82
	7	3.31	.88	.46
Sixth In-task SECS	1	2.84	.96	.59
	2	2.89	.97	.85
	3	2.82	.99	.86
	4	3.05	.98	.80
	5	2.89	.99	.86
	6	2.87	.98	.86
	7	2.94	1.06	.65

OTIM and SSS Reliability Scale

In order to insure that the OTIM, which was used to match students on levels of trait specific curiosity, was a reliable instrument, alpha reliability coefficients were calculated for each of the OTIM subscales and for the OTIM total scale. In addition an alpha reliability coefficient was calculated for the measure of trait diversive curiosity, i.e., the SSS scale. The means, standard deviations, and alpha reliabilities for the OTIM subscales, OTIM total scale and SSS scale are reported in Table 5.

For the data reported in Table 5, it may be noted that the OTIM total scale was found to have an alpha reliability of .94, indicating high internal consistency for this measure. In addition, the alpha reliabilities of the OTIM subscales were found to range from .54 to .87, with lowest alpha reliabilities being found for the Social Desirability, Diversive Curiosity, Novelty - Consultation, and Complexity - Consultation subscales. The alpha reliability of the SSS was found to be .89.

STAI Scale Reliability

The means, standard deviations, and alpha reliability coefficients were calculated for the STAI A-Trait scale, the 20-item pre-task STAI A-State measure, and the seven short form STAI A-State measures. This data is reported in Table 6.

As Table 6 indicates, the alpha reliability of the STAI A-Trait scale was found to be .91. The alpha reliabilities of the STAI A-State scales ranged from .86 to .95 for the long and short form versions of this scale.

In summary, the reliability results for both alpha reliability coefficients and item-remainder correlations reflect acceptable internal consistencies for the SECS scales administered during the experimental session. The OTIM scales, SSS scale and STAI scales were also found to have substantial internal consistencies.

TABLE 5

Means, Standard Deviations, and Alpha Reliability Coefficients
for the OTIM Subscales and OTIM Total Scale (N=152)

Scale	Scale Range	Mean	SD	Alpha
Ontario Test of Intrinsic Motivation				
Ambiguity	30-120	78.06	12.61	.87
Complexity	30-120	78.73	13.10	.87
Novelty	30-120	76.65	11.97	.85
Ambiguity - Thinking	110-40	24.64	4.66	.69
Ambiguity - Consultation	10-40	26.22	4.90	.72
Ambiguity - Observation	10-40	27.20	4.73	.64
Complexity - Thinking	10-40	25.46	5.13	.71
Complexity - Consultation	10-40	26.46	4.27	.59
Complexity - Observation	10-40	26.81	5.32	.75
Novelty - Thinking	10-40	22.36	5.09	.73
Novelty - Consultation	10-40	26.18	4.15	.57
Novelty - Observation	10-40	28.11	4.36	.63
Scientific Interest	10-40	21.77	5.71	.79
Diversive Curiosity	10-40	26.94	3.98	.58
Social Desirability	10-40	31.42	3.34	.54
Total	110-440	291.80	37.80	.94
Sensation Seeking Scale				
Total	2-58	44.11	2.50	.89

TABLE 6

Means, Standard Deviations, and Alpha Reliabilities of the STAI A-Trait and A-State Scales Administered During the Experiment (N=152)

Scale	Scale Range	Mean	SD	Alpha
A-Trait	20-80	37.72	9.52	.91
Pre-task A-State	20-80	37.08	9.00	.91
First In-task A-State	5-20	9.67	3.39	.88
Second In-task A-State	5-20	7.95	2.82	.86
Third In-task A-State	5-20	8.90	3.22	.89
Fourth In-task A-State	5-20	8.16	3.26	.91
Fifth In-task A-State	5-20	8.38	3.35	.86
Sixth In-task A-State	5-20	8.17	3.35	.86
Total In-task A-State	30-120	51.20	15.38	.95
Posttest A-State	5-20	10.01	4.15	.92

State Epistemic Curiosity Scale Validity Results

Concurrent Validity

As evidence of the concurrent validity of the two 20-item SECS scales and the six short-form SECS scales, these scales were correlated with the OTIM total scale and OTIM subscales. Since the OTIM was considered to be a trait measure of specific curiosity and the SECS was assumed to be a state measure of specific epistemic curiosity, moderately high positive correlations between these measures were expected. The correlations between the pre-task and post-task 20-item SECS scales, OTIM total scale, and OTIM subscales are reported in Table 7. The correlations between the six in-task short form SECS scales, OTIM total scale, and OTIM subscales can be found in Table 8.

As can be seen in Tables 7 and 8, significant positive correlations were found between both the 20-item and short form SECS scales and the OTIM total scales. In addition, the SECS scales were found to correlate significantly with a majority of the OTIM subscales. It should be noted that these moderately high positive correlations are within the range of correlations found between trait and state anxiety, as measured by the STAI (Spielberger et al., 1970).

TABLE 7

Correlations of Pre-Task and Post-Task SECS Scales with OTIM Total Scale and OTIM Subscales (N=152)

Ontario Test of Intrinsic Motivation Scales	Correlations Pre-Task SECS	 Post-Task SECS
Total	.52**	.37**
Ambiguity	.03	-.13
Complexity	.02	-.11
Novelty	.20*	.08
Ambiguity-Thinking	.44**	.31**
Ambiguity-Consultation	.34**	.19
Ambiguity-Observation	.47**	.32**
Complexity-Thinking	.43**	.35**
Complexity-Consultation	.45**	.22*
Complexity-Observation	.44**	.32**
Novelty-Thinking	.40**	.36**
Novelty-Consultation	.47**	.32**
Novelty-Observation	.44**	.27**
Diversive Curiosity	.04	.07
Scientific Interest	.52**	.42**
Social Desirability	.25**	.14

* $p < .05$
** $p < .01$

Construct Validity

Evidence which can be considered to bear on the construct validity of the SECS is provided by the correlations of the various SECS scales with the STAI A-State and A-Trait scales. As can be inferred from the Optimal Degree of Arousal Model, the constructs of state curiosity and state anxiety are differentiated in terms of intermediate versus high arousal levels, respectively. Thus, this inverse relationship should lead to moderately high negative correlations between these measures. In contrast, since trait anxiety implies relatively stable personality predispositions, relatively low negative correlations between the STAI A-Trait scale and the SECS measures would be expected.

The correlations between the eight SECS scales and eight STAI A-State scales given during the experimental session are reported in Table 9. This table also shows the intercorrelations of the various SECS scales and the A-State scales. Table 10 gives the correlations between the eight SECS scales and the STAI A-Trait scale.

For the data reported in Table 9, it can be noted that the majority of the SECS and A-State scales were significantly correlated in a negative direction, particularly for the scales given close in time during the experimental session. In addition,

TABLE 8

Correlations of Six In-Task Short Form SECS Scales with
OTIM Total Scale and OTIM Subscales (N=152)

Ontario Test of Intrinsic Motivation Scales	Correlations - SECS Scales 1	2	3	4	5	6
Total Scale	.34**	.29**	.16*	.29**	.19*	.25**
Ambiguity	-.04	-.04	-.07	-.06	-.08	-.16
Complexity	.01	-.03	-.09	-.07	-.08	-.14
Novelty	.14	.11	.04	.10	.07	.01
Ambiguity-Thinking	.30**	.24**	.14*	.22*	.16*	.18*
Ambiguity-Consultation	.21*	.20*	.06	.18*	.05	.08
Ambiguity-Observation	.29**	.26**	.11	.33**	.20	.25**
Novelty-Thinking	.31**	.21*	.19*	.26**	.22*	.30**
Novelty-Consultation	.38**	.30**	.10	.25**	.19*	.21*
Novelty-Observation	.25**	.23**	.10	.22*	.12	.16*
Diversive Curiosity	-.09	-.08	.00	.07	-.02	.01
Scientific Interest	.37**	.32**	.23**	.26**	.19*	.27**
Social Desirability	.19**	.24**	.16*	.19*	.23**	.18*

* $p < .05$
** $p < .01$

both the SECS scales and the STAI A-State scales were found to correlate highly among themselves. For the data reported in Table 10, it is instructive to note that, with the exception of the post-task SECS measure, all correlations of the SECS scales with trait anxiety were low negative, and only the correlation between A-Trait and the first in-task SECS scale reached significance. Also of interest were the findings of: (a) a correlation of -.01 between the OTIM and STAI A-Trait scale; and (b) correlations ranging from -.10 and -.15 between the OTIM and STAI A-State scales.

Additional evidence bearing on the construct validity of the SECS is provided by the correlations between the various SECS scales and portions of the achievement posttest. State epistemic curiosity was assumed to facilitate performance, particularly during the learning task, and thus it would be expected that those students scoring high on the SECS measures would make more correct responses on the achievement posttest. That is, moderately high positive correlations would be expected between the SECS scales and posttest sections. These correlations are reported in Table 11.

As Table 11 indicates, a majority of the SECS scales given during the experimental session were found to correlate significantly with the posttest achievement measures. Only the short form SECS scales which were given at the end of the Curiosity-Stimulating Instructions or No Instructions conditions and after the first half of the initial technical learning materials (i.e., short form SECS scales 1 and 2) were not found to significantly correlate with posttest performance. In addition, the highest

TABLE 9

Correlation Matrix of the Eight SECS Scales
and Eight STAI A-State Scales (N=152)

Scales	Pre Task	State Anxiety					
		1	2	3	4	5	6
Pre-Task A-State	.91	.41*	.43*	.48*	.41*	.39*	.34*
A-State 1		.88	.73*	.45*	.39*	.28*	.37*
A-State 2			.86	.55*	.52*	.42*	.48*
A-State 3				.89	.75*	.65*	.60*
A-State 4					.91	.75*	.68*
A-State 5						.86	.70*
A-State 6							.86
Posttest A-State							
Pre-Task State Curiosity							
State Curiosity 1							
State Curiosity 2							
State Curiosity 3							
State Curiosity 4							
State Curiosity 5							
State Curiosity 6							
Post-Task State Curiosity							

Post Test	Pre Task	State Curiosity 1	2	3	4	5	6	Post Task
.41*	-.30*	-.27*	-.26*	-.07	-.12	-.10	-.11	-.10
.45*	-.08	-.22	-.22	-.14	-.09	-.01	-.05	.00
.50*	-.11	-.32*	-.30*	-.18	-.14	-.10	-.06	-.06
.62*	-.13*	-.24	-.25*	-.30*	-.22	-.22	-.25*	-.14
.63*	-.17	-.35*	-.27*	-.21	-.29*	-.30*	.30*	-.20
.58*	-.19	-.36*	-.30*	-.26*	-.26*	-.31*	.27*	-.21
.73*	-.12	-.27*	-.19	-.21	-.23	-.19	.31*	.19
.92	-.18	-.28*	-.22	-.20	-.20	-.12	-.21	-.20
	.88	.57*	.55*	.20	.31*	.26*	.26*	.54*
		.81	.77*	.41*	.50*	.57*	.45*	.52*
			.88	.53*	.58*	.54*	.45*	.57*
				.86	.51*	.58*	.48*	.57*
					.91	.65*	.64*	.63*
						.91	.79*	.68*
							.93	.72*
								.94

Correlations underlined are significant at the p < .05 level; correlations followed by an asterisk are significant at the p < .01 level. The alpha reliabilities for the respective scales are given on the diagonals.

TABLE 10

Correlations of the 20-Item and Short Form
State Epistemic Curiosity Scales with
the STAI A-Trait Scale (N=152)

State Epistemic Curiosity Scale	Correlations A-Trait Scale
Pre-Task SECS	-.11
Short Form SECS 1	-.19*
Short Form SECS 2	-.14
Short Form SECS 3	-.08
Short Form SECS 4	-.05
Short Form SECS 5	-.14
Short Form SECS 6	-.05
Posttask SECS	.02

* $p < .05$

positive correlations were found between the post-task SECS measure, which asked students to reflect on how they felt while learning the materials, and posttest performance. The predictability of the SECS as a state measure of curiosity is further supported by the fact that correlations between trait curiosity, as measured by the OTIM, and the achievement posttest were negligible ($r = .07$ and $r = .05$ for the initial and remaining technical portions of the posttest, respectively).

Evidence of the construct validity of the SECS scales is also provided by the correlations of these scales with the Diversive Curiosity subscale of the OTIM and the Sensation Seeking Scale (SSS). Since the SECS is assumed to be a measure of specific epistemic curiosity, low positive correlations between the SECS measures and measures of diversive curiosity would be expected. Tables 7 and 8 indicate that the SECS scales did not correlate significantly with the Diversive Curiosity subscale of the OTIM. The correlations of the various SECS scales given during the experimental session with the SSS are reported in Table 12.

As indicated in Table 12, the SECS scales were not found to correlate significantly with trait diversive curiosity, as measured by the SSS. In addition, a nonsignificant correlation of -.12 was found between trait specific curiosity, as measured by the OTIM, and SSS scores. The SSS was not found to correlate significantly with

TABLE 11

Correlations of Eight State Epistemic Curiosity Measures
with Posttest Achievement Measures (N=152)

	Posttest Sections		
Measures	Initial Technical	Remaining Technical	Total Technical
Pre-Task SECS	.20*	.18*	.19*
Short Form SECS 1	.16*	.17*	.18*
Short Form SECS 2	.15	.11	.13
Short Form SECS 3	.06	-.02	-.01
Short Form SECS 4	.28**	.26**	.29**
Short Form SECS 5	.19*	.18*	.20*
Short Form SECS 6	.20*	.30**	.30**
Post-Task SECS	.25**	.31**	.32*

* $p < .05$
** $p < .01$

the STAI A-Trait scale (r = -.04), nor with the majority of STAI A-State scales given during the experimental session (r's = -.04 to .17). The only significant correlation between the SSS and A-State was found on the fifth in-task A-State measure (i.e., r = .17, $p < .05$).

In summary, the State Epistemic Curiosity Scale (SECS) was found to have supportive concurrent validity as evidenced by the moderately high positive correlations between the SECS scales and OTIM scales. The construct validity findings, in line with predictions derived from the Optimal Degree of Arousal Model, included: (a) significant negative correlations between state epistemic curiosity and state anxiety; (b) significant positive correlations between state epistemic curiosity and posttest performance; and (c) no significant correlations between state epistemic curiosity and diversive curiosity. In addition, negligible correlations were found between trait curiosity, state anxiety, and performance, indicating the greater predictibility of the SECS.

TABLE 12

Correlations of the 20-Item and Short Form SECS Scales
with the Sensation Seeking Scale (N=152)

State Epistemic Curiosity Scales	Correlations SSS Scale
Pre-Task SECS	-.05
Short Form SECS 1	-.07
Short Form SECS 2	.04
Short Form SECS 3	.04
Short Form SECS 4	.04
Short Form SECS 5	.02
Short Form SECS 6	-.01
Post-Task SECS	-.07

Curiosity and Performance Results

Curiosity Analyses

Effects of Response Mode and Instruction Conditions on In-Task State Curiosity Scores for Low and High Trait Curious Students

In order to investigate the hypotheses that (a) high trait curious students would have higher levels of state curiosity during the CAI task than low trait curious students, (b) levels of state curiosity would change over time, and (c) students in the Curiosity-Stimulating Instructions conditions would have higher levels of state curiosity than students in the No Instruction conditions, a 2 x 2 x 2 x 6 analysis of variance with repeated measures on the last factor was calculated. The independent variables in this analysis were response mode conditions (R, CR), instruction conditions (CSI, NI), levels of trait curiosity (LC, HC), and measurement periods (six in-task state curiosity measures). The students were divided into low and high trait curious groups on the basis of their scores on the OTIM. The distribution of these scores was ranked and split at the median. The Reading-CSI, Reading-NI, Constructed Response-CSI, and Constructed Response-NI groups were then separated out of this distribution; 21 students were dropped from the original group tested in order to yield an equal number of students in each group. The range of low trait curiosity scores was 204 to 290; high trait curiosity scores ranged from 291 to 417. The dependent variable in this analysis was mean state curiosity scores on the six short form SECS measures given during the CAI learning task.

The means and standard deviations of low and high trait curious students in response mode and instruction conditions on the six in-task SECS measures are reported in Table 13.

TABLE 13

Mean State Curiosity Scores on the Six In-Task SECS Measures for Low and High Trait Curious Students in Response Mode and Instruction Conditions

Groups		Pre	Post	Measurement Periods			
		CSI/NI	CSI/NI	Post T_I1	Post T_I2	Post T_R1	Post T_R2
All groups (N=152)							
	Mean	24.21	24.20	24.41	22.31	22.49	20.30
	SD	3.14	3.45	3.77	4.97	5.04	5.84
Reading–CSI	LC (n=19)						
	Mean	22.74	23.63	25.16	20.74	22.37	19.21
	SD	2.75	3.62	3.24	5.33	5.36	6.28
	HC (n=19)						
	Mean	25.74	25.58	24.90	23.68	25.00	23.47
	SD	2.02	2.46	3.45	3.73	3.62	3.92
Reading–NI	LC (n=19)						
	Mean	23.95	24.11	24.11	21.16	22.53	20.11
	SD	2.97	3.11	3.41	5.54	4.78	5.32
	HC (n=19)						
	Mean	24.00	23.68	25.68	23.47	23.42	23.[illegible]7
	SD	3.13	3.53	3.06	3.86	3.27	4.27
Constructed Response–CSI	LC (n=19)						
	Mean	23.00	24.42	22.84	22.11	21.21	19.32
	SD	3.74	3.98	3.98	4.84	5.42	5.06
	HC (n=19)						
	Mean	25.58	24.48	23.95	22.58	21.74	18.58
	SD	2.67	3.81	4.34	4.11	4.41	6.62
Constructed Response–NI	LC (n=19)						
	Mean	22.84	22.58	23.37	20.11	19.37	17.58
	SD	3.75	3.85	4.72	6.64	6.39	6.11
	HC (n=19)						
	Mean	25.84	26.05	25.26	24.63	24.32	20.68
	SD	2.04	1.84	3.45	4.07	4.92	6.58

Results of the analysis of variance on these data revealed two significant interactions: (a) response modes by levels of trait curiosity by measurement periods ($F = 2.60$, $df = 5/720$, $p < .05$); and (b) response modes by measurement periods ($F = 5.30$, $df = 5/720$, $p < .001$). The triple interaction plotted in Figure 5 indicates that low trait curious students in both the Reading and Constructed Response groups had lower levels of state curiosity throughout the task than high trait curious students; however, the sharpest decreases in state curiosity across time were noted for the Constructed Response groups relative to the Reading groups. In addition, whereas high trait curious students in the Constructed Response groups decreased in state curiosity scores to a level comparable to that of low trait curious students in the Reading groups by the end of the CAI task (i.e., Post T_R2), high trait curious students in the Reading groups retained a relatively high level of state curiosity throughout the CAI task.

The response mode by measurement periods interaction plotted in Figure 6 clarifies the relationship between these variables, in that the Constructed Response groups had the sharpest decline in state curiosity across measurement periods relative to the Reading groups. Whereas state curiosity levels also tended to decline across time for the Reading groups, state curiosity scores increased following the first half of the initial technical learning materials and after the first half of the remaining technical learning materials for this group.

All students were also found to have decreases in state curiosity scores across the six measurement periods ($F = 44.48$, $df = 5/720$, $p < .001$), and high trait curious students ($\bar{X} = 24.00$) were found to have significantly higher state curiosity scores than low trait curious students ($\bar{X} = 21.98$). This main effect of trait curiosity was significant at the $p < .001$ level ($F = 13.50$, $df = 1/144$). No other main effects or interactions in this analysis were found to be significant.

Effects of Response Mode and Instruction Conditions on Pre- and Post-Task State Curiosity Scores for Low and High Trait Curious Students

In order to investigate whether there were significant differences between groups on the pre- and post-task state curiosity measures, as measured by the 20-item SECS scales, a 2 x 2 x 2 x 2 analysis of variance with repeated measures on the last factor was calculated. The independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), levels of trait curiosity (LC, HC), and measurement periods (Pre-Task, Post-Task). The dependent variable was mean state curiosity scores on the pre- and post-task SECS scales.

The means and standard deviations of pre- and post-task state curiosity scores for low and high trait curious students in response mode and instruction conditions are presented in Table 14.

Results of the analysis of variance on these data indicated that all students ($\bar{X} = 62.67$) had significantly higher state curiosity scores on the pre-task SCS given prior to the experimental session than on the post-task measure given after the task. This main effect of measurement periods was significant at the $p < .001$ level ($F = 18.49$, $df = 1/144$). In addition, high trait curious students ($\bar{X} = 65.16$) were found to have significantly higher state curiosity scores than low trait curious students ($\bar{X}$

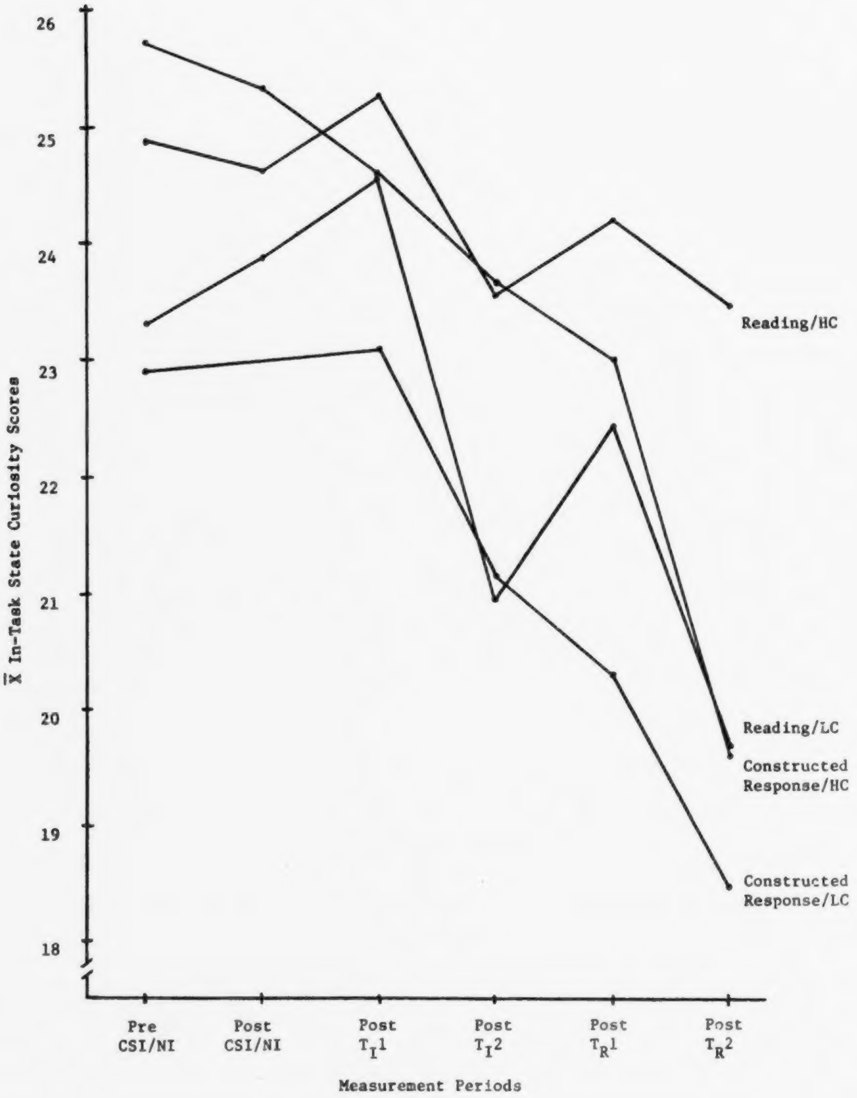


Figure 5.—Response modes by levels of trait curiosity by measurement periods interaction on state curiosity scores.

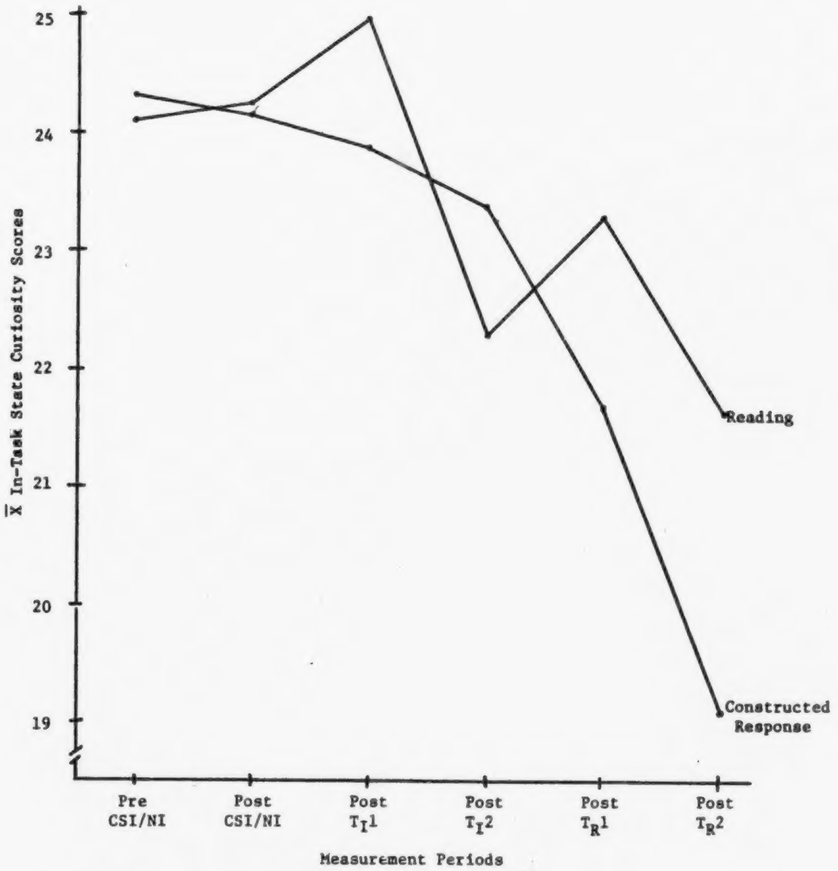


Figure 6.—Response modes by measurement periods interaction on state curiosity scores.

= 56.11). This main effect of trait curiosity was significant at the $p < .001$ level (F = 36.9l, df = 1/144). No other main effects or interactions approached significance in this analysis.

In summary, the results of the curiosity data analyses indicated that, as predicted, high trait curious students had higher levels of state curiosity during the CAI task than low trait curious students. In addition, the hypothesis that levels of state curiosity would change over time was supported, with all groups having highest levels of state curiosity at the beginning of the CAI task, and decreases in state curiosity during the technical learning materials. These decreases in state curiosity, however, were found to be more marked for students in the Constructed Response groups relative

TABLE 14

Mean State Curiosity Scores on the Pre- and Post-Task SECS Measure for Low and High Trait Curious Students in Response Mode and Instruction Conditions

	Trait Curiosity Groups		State Curiosity Measure	
			Pre-Task	Post-Task
Reading—CSI	LC (n=19)			
		Mean	58.42	55.16
		SD	7.51	11.01
	HC (n=19)			
		Mean	67.84	63.79
		SD	7.14	10.64
Reading—NI	LC (n=19)			
		Mean	58.53	53.05
		SD	15.49	16.60
	HC (n=19)			
		Mean	66.00	64.42
		SD	7.62	11.58
Constructed Response—CSI	LC (n=19)			
		Mean	58.74	55.47
		SD	5.98	12.69
	HC (n=19)			
		Mean	66.05	57.90
		SD	9.32	12.51
Constructed Response—NI	LC (n=19)			
		Mean	57.53	52.00
		SD	7.52	15.61
	HC (n=19)			
		Mean	68.21	65.05
		SD	5.69	11.37

to students in the Reading groups. Furthermore, a comparison of the changes in state curiosity on the pre-task SECS measure given prior to the experimental session and on the post-task SECS measure given at the end of the experimental session revealed that state curiosity scores for all groups significantly decreased from the pre-task to post-task measure.

There was also an interesting interaction found between levels of trait curiosity, response modes, and in-task measurement periods. This interaction indicated that low trait curious students in both the Reading and Constructed Response groups had lower levels of state curiosity during the CAI task than high trait curious students; however, the low and high trait curious students in the Constructed Response groups had the greatest decreases in state curiosity relative to low and high trait curious students in the Reading groups. In addition, whereas high trait curious students in the Constructed Response groups had decreases in state curiosity relative to low and high trait curious students in the Reading groups, only high trait curious students in the Reading groups retained a relatively high level of state curiosity throughout the CAI task. Contrary to predictions, however, students in the Curiosity-Stimulating Instructions conditions were not found to have higher state curiosity scores during the task than students in the No Instructions condition.

Curiosity and Performance Analyses

Effects of Response Mode and Instruction Conditions on Posttest Performance for Low and High Trait Curious Students

Two 2 x 2 x 2 analyses of variance were calculated to determine the effects of response modes, instruction conditions, and levels of trait curiosity on achievement posttest performance. In both analyses, the independent variables were response modes (R, CR), instruction conditions (CSI, NI), and levels of trait curiosity (LC, HC). The dependent variable in the first analysis was mean correct responses on the initial technical portion of the posttest; mean correct responses on the remaining technical portion of the posttest was the dependent variable in the second analysis.

The means and standard deviations of correct responses on the initial technical and remaining technical posttest for low and high trait curious students in response mode and instruction conditions are reported in Tables 15 and 16, respectively.

Results of the analysis of variance on the initial technical posttest data presented in Table 15 indicated that students performed differentially dependent upon their level of trait curiosity and instruction condition ($F = 4.34$, $df = 1/144$, $p < .05$). This interaction is shown in Figure 7, and indicates that low trait curious students in the Curiosity-Stimulating Instructions conditions performed better on the initial technical portion of the posttest than low trait curious students in the No Instructions conditions, whereas there was relatively little difference in the performance of high trait curious students in the Curiosity-Stimulating and No Instructions conditions. In addition, the students in the Constructed Response groups ($\overline{X} = 22.67$) were found to perform significantly better than students in the Reading groups ($\overline{X} = 19.64$). This main effect of response modes was significant at the $p < .001$ level ($F = 27.62$, $df = 1/144$). No other main effects or interactions approached significance.

Results of the analysis of variance on the remaining technical posttest data reported in Table 16 revealed no significant main effects or interactions.

Effects of Response Mode and Instruction Conditions on Posttest Performance for Low, Medium, and High State Curious Students

In order to investigate the hypothesis that high state curious students would make more correct responses on the posttest than low state curious students, two sets

TABLE 15

Mean Correct Responses on the Initial Technical Posttest for Low and High Trait Curious Students in Response Mode and Instruction Conditions

Groups	Trait Curiosity Levels	
	Low	High
Reading - CSI (n=38)		
Mean	19.42	20.58
SD	3.53	5.00
Reading - NI (n=38)		
Mean	18.59	20.00
SD	3.12	3.04
Constructed Response - CSI (n=38)		
Mean	24.11	22.16
SD	2.54	4.03
Constructed Response - NI (n=38		
Mean	20.90	23.53
SD	3.78	2.65

of two 2 x 2 x 3 analyses of variance were computed. Independent variables in both sets of analyses were response modes (R, CR), instruction conditions (CSI, NI), and levels of state curiosity (low, medium, high). The dependent variables in each set of analyses were: (a) mean correct responses on the initial technical portion of the achievement posttest; and (b) mean correct responses on the remaining technical portion of the achievement posttest.

In the first set of analyses, students were divided into low, medium, and high state curious groups on the basis of their summed scores on the six SECS measures given during the CAI learning task. Low state curiosity scores ranged from 76-130; medium state curiosity scores ranged from 131-150; the range of high in-task state curiosity scores was 151-168. In the second set of analyses, students were divided into low, medium, and high state curious groups on the basis of their scores on the 20-item SECS measure given at the end of the experimental session. The range of low post-task state curiosity scores was 26-53; medium post-task state curiosity scores ranged from 54-67; the range of high post-task state curiosity scores was 68-80.

In-task state curiosity analyses. The means and standard deviations for the low, medium, and high in-task state curious groups on the initial technical and remaining technical portions of the posttest in response mode and instruction conditions are reported in Tables 17 and 18, respectively.

TABLE 16

Mean Correct Responses on the Remaining Technical Posttest for Low and High Trait Curious Students in Response Mode and Instruction Conditions

Groups	Trait Curiosity Levels Low	High
Reading - CSI (n=38)		
Mean	32.95	35.05
SD	17.40	16.97
Reading - NI (n=38)		
Mean	35.32	38.42
SD	14.36	18.69
Constructed Response - CSI (n=38)		
Mean	48.84	39.11
SD	13.66	18.42
Constructed Response - NI (n=38)		
Mean	34.42	40.05
SD	21.79	14.18

Results of the first analysis on the initial technical posttest data reported in Table 17 indicated that high state curious students ($\bar{X}$ = 22.2[illegible]) made more correct responses on the initial technical posttest than medium ($\bar{X}$ = 21.26) or low ($\bar{X}$ = 19.96) state curious students. The main effect of in-task state curiosity was significant at the $p < .001$ level (F - 7.27, df = 2/140). In addition, students in the Constructed Response groups (X = 22.67) made significantly more correct responses on the initial technical posttest than students in the Reading groups ($\bar{X}$ = 19.64). This main effect of response mode conditions was significant at the $p < .001$ level (F = 33.97, df = 1/140). No other main effects or interactions were significant.

Results of the analysis of the remaining technical posttest data presented in Table 13 again revealed the main effect of in-task state curiosity (F = 5.56, df = 2/140, $p < .01$), indicating that high state curious students ($\bar{X}$ = 43.65) made more correct responses on the remaining technical posttest than medium ($\bar{X}$ = 36.64) or low ($\bar{X}$ = 33.65) state curious students. No other main effects or interactions were significant.

Post-task state curiosity analyses. The means and standard deviations for low, medium, and high post-task state curious groups on the initial technical and remaining technical posttest in response mode and instruction conditions are reported in Tables 19 and 20, respectively.

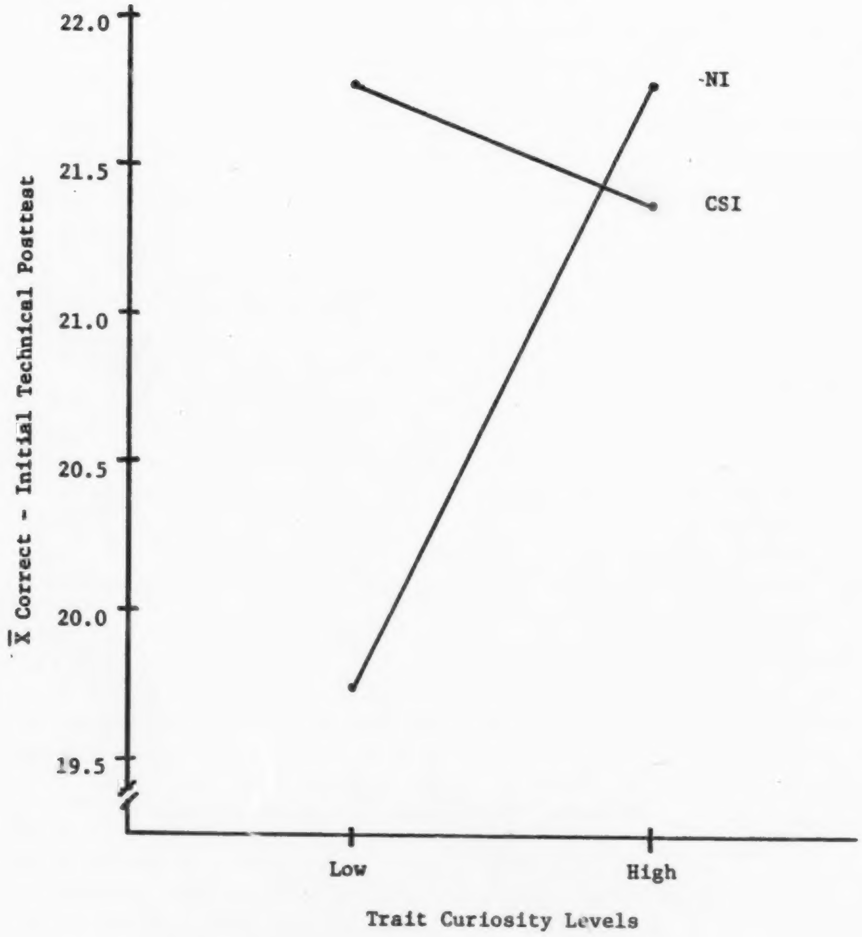


Figure 7.—Instruction conditions by trait curiosity levels interaction on initial technical posttest scores

Results of the analysis of initial technical posttest performance data, presented in Table 19, again revealed that students in the Constructed Response groups ($\bar{X} = 22.67$) made significantly more correct responses than students in the Reading ($\bar{X} = 19.64$) groups ($F = 28.09$, $df = 1/140$, $p < .001$). The main effect of post-task state curiosity was also highly significant ($F = 7.83$, $df = 2/140$, $p < .001$), indicating that high post-task state curious students ($\bar{X} = 22.55$) made more correct responses than medium ($\bar{X} = 21.05$) or low ($\bar{X} = 19.98$) state curious students. No other main effects or interactions approached significance.

TABLE 17

Mean Correct Responses on the Initial Technical Posttest for Low, Medium, and High In-Task State Curiosity Students in Response Mode and Instruction Conditions

Groups	In-Task State Curiosity		
	Low	Medium	High
Reading - CSI (n=38)			
Mean	20.00	19.87	20.15
SD	2.31	5.67	4.10
Reading - NI (n=38)			
Mean	17.80	18.93	20.85
SD	3.80	2.52	2.67
Constructed Response - CSI (n=38)			
Mean	21.25	24.40	24.58
SD	4.49	1.58	1.38
Constructed Response - NI (n=38)			
Mean	20.00	23.70	23.62
SD	3.76	2.16	2.72

Results of the analysis of the remaining technical posttest performance data, presented in Table 20, indicated that students in the Constructed Response groups ($\bar{X} = 40.61$) performed significantly better than students in the Reading ($\bar{X} = 35.43$) groups ($F = 4.03$, $df = 1/140$, $p < .05$). The main effect of post-task curiosity was also significant ($F = 12.65$, $df = 2/140$, $p < .001$), with high state curious students ($\bar{X} = 44.68$) performing better on the remaining technical posttest than medium ($\bar{X} = 40.33$) or low ($\bar{X} = 30.43$) state curious students In addition, two interactions were significant: (a) response modes by instruction conditions, shown in Figure 8 ($F = 5.52$, $df = 1/140$, $p < .05$); and (b) instruction conditions by post-task state curiosity levels, shown in Figure 9 ($F = 3.85$, $df = 2/140$, $p < .05$).

The interaction shown in Figure 8 indicates that whereas students in the Constructed Response-CSI condition performed better than students in the Constructed Response-NI group on the remaining technical posttest, the reverse was true for students in the Reading-CSI and Reading-NI groups. The interaction shown in Figure 9 indicates that there was relatively little difference in the performance of low, medium, and high post-task state curious students in the Curiosity-Stimulating Instructions conditions; but for students in the No Instructions conditions, high post-task state curious students performed better than medium or low post-task state curious students on the remaining technical posttest. No other main effects or interactions approached significance.

TABLE 18

Mean Correct Responses on the Remaining Technical Posttest for Low, Medium, and High In-Task State Curiosity Students in Response Mode and Instruction Conditions

Groups	In-Task State Curiosity		
	Low	Medium	High
Reading - CSI (n=38)			
Mean	36.70	32.67	32.08
SD	15.66	19.88	15.31
Reading - NI (n=38)			
Mean	29.00	32.67	47.77
SD	17.73	16.15	13.10
Constructed Response - CSI (n=38)			
Mean	40.38	41.20	51.08
SD	17.90	17.53	13.16
Constructed Response - NI (n=38)			
Mean	27.53	40.70	45.77
SD	16.60	17.53	16.74

To summarize, with respect to the trait curiosity and performance data analyses, levels of trait curiosity and instruction conditions were found to differentially affect students' performance on the initial technical portion of the achievement posttest. Whereas low and high trait curious students in the Curiosity-Stimulating Instructions condition were found to perform relatively the same on this portion of the posttest, high trait curious students in the No Instructions condition performed better than did low trait curious students. The effects of the Curiosity-Stimulating Instructions condition would thus seem to be that of improving the performance of low trait curious students relative to high trait curious students.

The results of the state curiosity and performance data analyses indicated, as hypothesized, that high state curious students made more correct responses than low state curious students on the initial and remaining technical portions of the achievement posttest, both when divided into low, medium, and high state curious groups on the basis of summed in-task state curiosity scores and on the basis of post-task state curiosity scores. In addition, students in the Constructed Response groups were found to make more correct responses than students in the Reading groups on both portions of the posttest. This relationship was also found for low, medium, and high post-task state curious students in instruction conditions on the remaining technical posttest. Also, on the remaining technical posttest, response modes interacted with

TABLE 19

Mean Correct Responses on the Initial Technical Posttest for Low, Medium, and High Post-Task State Curious Students in Response Mode and Instruction Conditions

Groups	Post-Task State Curiosity Level		
	Low	Medium	High
Reading - CSI (n=38)			
Mean	19.80	20.13	20.00
SD	1.99	4.52	5.61
Reading - NI (n=38)			
Mean	17.09	19.44	21.67
SD	3.48	2.20	2.55
Constructed Response - CSI (n=38)			
Mean	22.25	23.31	24.44
SD	3.34	4.37	1.59
Constructed Response - NI (n=38)			
Mean	19.79	22.75	24.06
SD	3.75	2.38	2.44

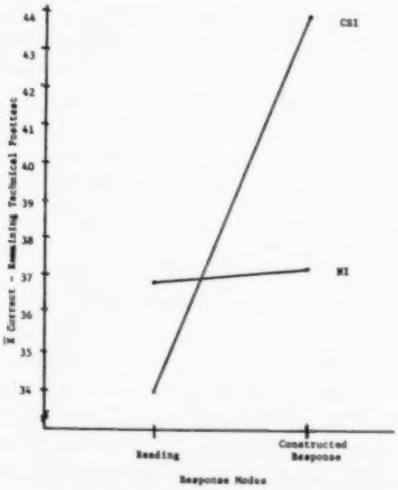


Figure 8.—Instruction conditions by response modes interaction on remaining technical posttest scores.

TABLE 20

Mean Correct Responses on the Remaining Technical Posttest for Low, Medium, and High Post-Task State Curious Students in Response Mode and Instruction Conditions

Groups	Post-Task State Curiosity Level Low	Medium	High
Reading - CSI (n=38)			
Mean	31.40	36.67	32.92
SD	19.78	15.99	16.80
Reading - NI (n=38)			
Mean	23.64	35.56	55.67
SD	10.45	14.11	7.75
Constructed Response - CSI (n=38)			
Mean	37.75	47.00	50.67
SD	18.71	14.38	13.65
Constructed Response - NI (n=38)			
Mean	26.71	40.75	44.69
SD	17.01	12.31	18.46

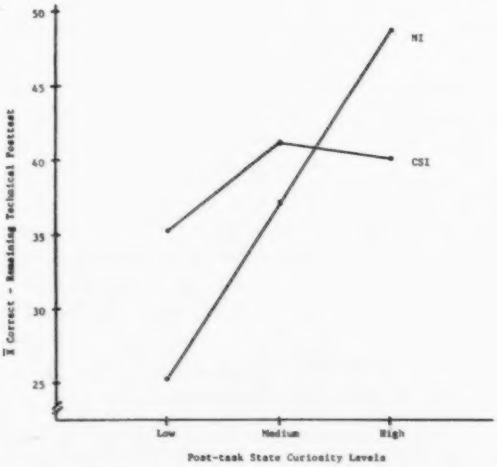


Figure 9.–Instruction conditions by levels of post-task state curiosity levels on remaining technical posttest scores.

instruction conditions, indicating that Constructed Response-CSI students performed better than Constructed Response-NI students, whereas Reading-NI students performed better than Reading-CSI students on this portion of the posttest.

Anxiety and Performance Results

Anxiety Analyses

Effects of Response Mode and Instruction Conditions on In-Task A-State Scores for Low and High A-Trait Students

To investigate the hypotheses that (a) high A-Trait students would have higher levels of A-State throughout the experimental session than low A-Trait students and (b) levels of A-State would change over time, a 2 x 2 x 2 x 6 analysis of variance with repeated measures on the last factor was calculated. The independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), levels of A-Trait (LA, HA), and measurement periods (six short form STAI A-State measures). The dependent measure was mean state anxiety scores on the six measures given during the CAI task.

The means and standard deviations for low and high A-Trait students in response mode and instruction conditions on the six A-State measures are reported in Table 21.

Results of the analysis of variance on these data revealed a significant interaction between response modes and measurement periods ($F = 11.37$, $df = 5/720$, $p < .001$), which is plotted in Figure 10. This interaction indicated that whereas A-State scores decreased throughout the CAI task for students in the Reading groups, students in the Constructed Response groups had variable increases in A-State scores during the CAI task. In addition, there was a significant interaction between response modes, measurement periods, and levels of A-Trait ($F = 2.48$, $df = 5/720$, $p < .05$). This interaction is shown in Figure 11, which indicates that whereas high and low A-Trait students in the Constructed Response groups had relatively the same pattern of increases and decreases in A-State scores across the experimental task, high and low A-Trait students in the Reading groups had differential changes in A-State scores during the CAI task. That is, high A-Trait students in the Reading groups had steady decreases in A-State across measurement periods, while low A-Trait students in the Reading groups had decreases in A-State during the initial technical materials and increases in A-State during the remaining technical materials.

The main effect of response mode conditions was also significant ($F = 4.53$, $df = 1/144$, $p < .05$), in that students in the Constructed Response groups ($\bar{X} = 8.94$) were found to have higher A-State scores than students in the Reading groups ($\bar{X} = 8.15$). The high A-Trait students ($\bar{X} = 9.69$) were also found to have higher A-State scores than low A-Trait students ($X = 7.39$). This main effect of A-Trait was significant at the $p < .001$ level ($F = 38.28$, $df = 1/144$). Furthermore, A-State scores were found to significantly change across the measurement periods ($F = 14.50$, $df = 5/720$, $p < .001$). That is, all students had highest levels of A-State initially, lowest levels of A-State following the Curiosity-Stimulating or No Instructions conditions, and rises in A-State following the initial technical learning materials. No other main effects or interactions approached significance in this analysis.

TABLE 21

Mean A-State Scores on Six In-Task STAI A-State Measures for Low and High A-Trait Students in Response Mode and Instruction Conditions

		Measurement Periods					
	Groups	Pre-Instructions	Post-Instructions	Post T_I1	Post T_I2	Post T_R1	Post T_R2
All groups (N=152)							
	Mean	9.70	7.95	8.90	8.16	8.38	8.17
	SD	3.39	2.83	3.23	3.27	3.36	3.36
Reading–CSI	LA (n=19)						
	Mean	8.47	7.05	6.68	6.16	6.37	6.79
	SD	3.39	2.35	2.08	1.86	1.86	2.66
	HA (n=19)						
	Mean	11.90	10.26	9.84	8.74	8.37	8.00
	SD	3.64	2.86	3.64	3.45	3.29	2.62
Reading–NI	LA (n=19)						
	Mean	7.47	6.63	6.90	6.37	6.21	6.47
	SD	2.72	2.14	2.31	1.74	1.58	2.26
	HA (n=19)						
	Mean	11.63	9.74	9.21	9.26	8.84	7.84
	SD	2.85	3.00	2.89	3.58	3.29	2.71
Constructed Response–CSI	LA (n=19)						
	Mean	8.68	6.53	9.16	7.37	8.16	7.58
	SD	2.89	1.58	3.32	2.77	2.57	2.55
	HA (n=19)						
	Mean	10.16	7.79	9.90	9.63	9.63	10.00
	SD	2.85	2.37	3.23	3.29	3.55	4.16
Constructed Response–NI	LA (n=19)						
	Mean	8.37	6.58	8.74	8.00	8.32	8.05
	SD	3.13	2.59	3.57	3.50	3.28	3.64
	HA (n=19)						
	Mean	10.90	9.05	10.74	9.74	11.11	10.32
	SD	3.07	2.80	2.58	3.62	4.28	4.23

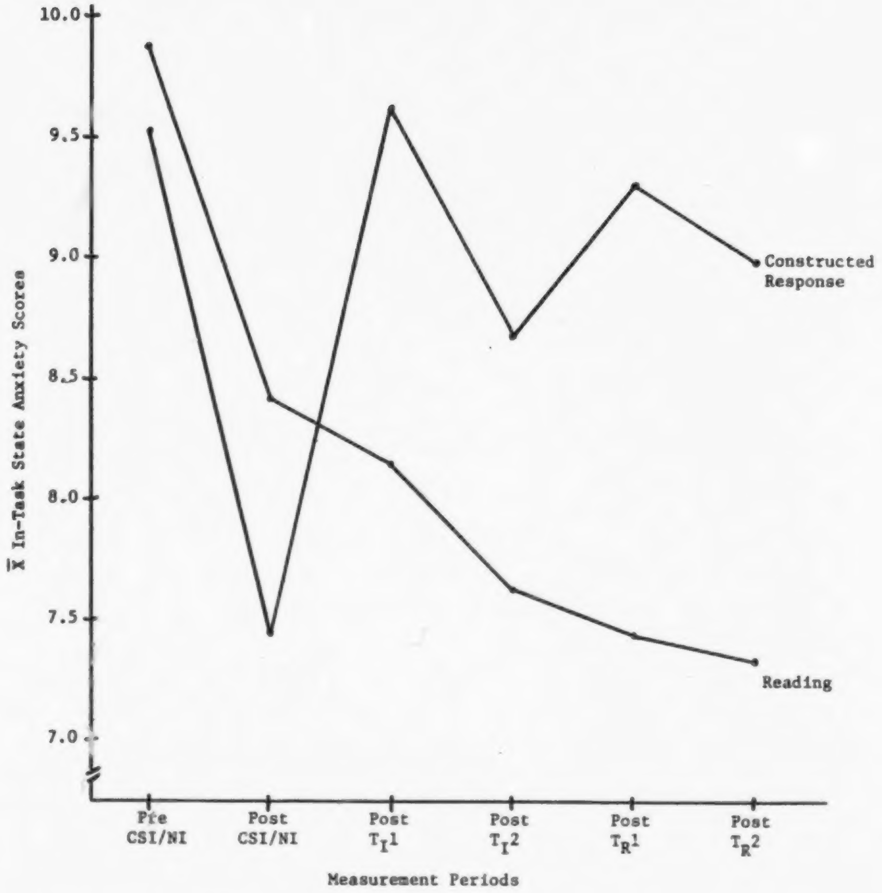


Figure 10.—Response modes by measurement periods interaction on in-task state anxiety scores.

Since the interaction plotted in Figure 10 indicated that the Reading and Constructed Response groups appeared to have a decrease in A-State following the Curiosity-Stimulating or No Instructions conditions, an additional 2 x 2 x 2 x 2 analysis of variance with repeated measures on the last factor was calculated to explicate these two A-State measurement periods. The independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), levels of A-Trait (LA, HA), and measurement periods (pre/post CSI or NI). The dependent variables were mean A-State scores on the first in-task A-State measure and on the A-State measure following the Curiosity-Stimulating or No Instructions conditions.

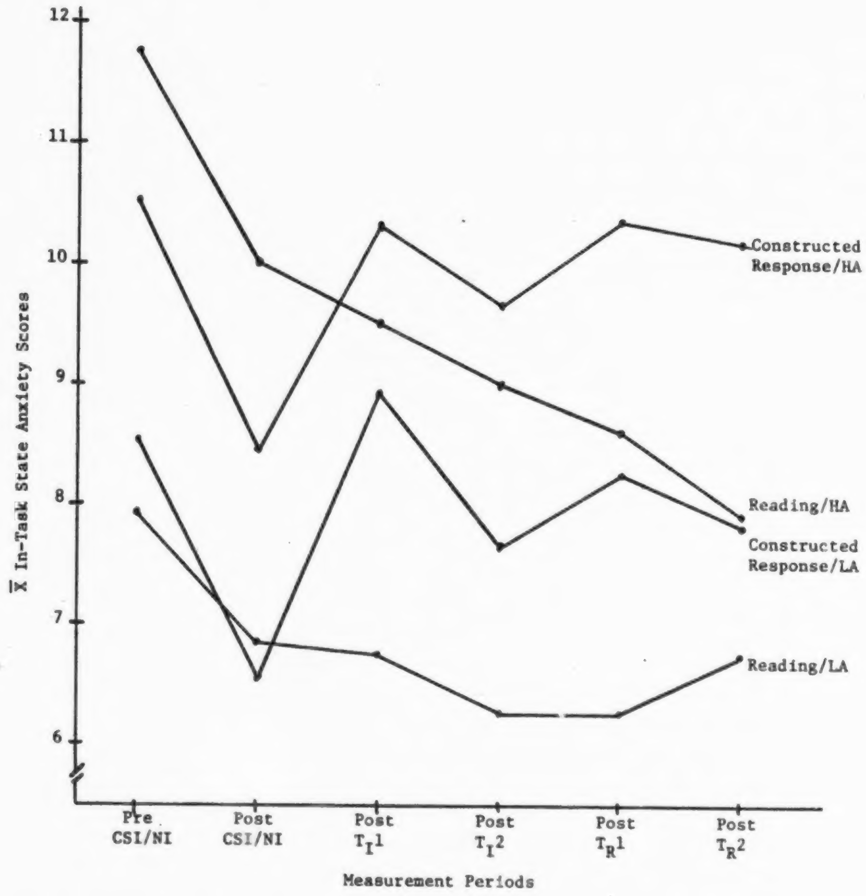


Figure 11.—Response modes by levels of trait anxiety by measurement periods interaction on in-task state anxiety scores.

Results of the analysis of variance revealed a significant main effect of measurement periods (F = 81.63, df = 1/144, $p < .001$), which indicated that A-State scores were significantly lower following the Curiosity-Stimulating or No Instructions conditions ($\bar{X}$ = 7.95) than before these conditions ($\bar{X}$ = 9.70). In addition, the main effect of A-Trait was also significant (F = 43.11, df = 1/144, $p < .001$). That is, high A-Trait students ($\bar{X}$ = 10.18) had significantly higher A-State scores than low A-Trait students ($\bar{X}$ = 7.47). No other main effects or interactions were significant.

TABLE 22

Mean A-State Scores on the Posttest A-State Measure
for Low and High A-Trait Students in Response
Mode and Instruction Conditions

Groups	Trait Anxiety Levels	
	Low	High
Reading - CSI (n=38)		
Mean	8.00	12.74
SD	3.54	4.34
Reading NI (n=38)		
Mean	8.58	10.74
SD	3.76	3.56
Constructed Response - CSI (n=38)		
Mean	8.42	10.53
SD	3.64	3.61
Constructed Response - NI (n=38)		
Mean	8.63	12.47
SD	3.78	4.31

Effects of Response Mode and Instruction Conditions on Posttest A-State Scores for Low and High A-Trait Students

In order to determine whether high A-Trait students would have higher levels of A-State during the achievement posttest than low A-Trait students, and determine the effects of response mode and instruction conditions on posttest A-State scores, a 2 x 2 x 2 analysis of variance was calculated. Independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), and levels of A-Trait (LA, HA). The dependent variable was mean A-State scores on the posttest A-State measure.

The means and standard deviations of posttest A-State scores for low and high A-Trait students in response mode and instruction conditions are given in Table 22.

Results of the analysis of variance on these data indicated that high A-Trait students ($X = 11.62$) had higher A-State scores than low A-Trait students ($X = 8.41$). This main effect of trait anxiety was significant at the $p < .001$ level ($F = 26.41$, $df = 1/144$.) No other main effects or interactions were significant.

In summary, the results of the anxiety data analyses supported the hypotheses that high A-Trait students would have higher levels of A-State throughout the CAI learning task and posttest than low A-Trait students, and that levels of A-State would change over time. All groups of students were found to have high levels of A-State at the beginning of the CAI task, lowest levels following the Curiosity-Stimulating or No Instructions conditions, moderate levels during the technical learning materials, and highest levels of A-State during the achievement posttest. However, dependent upon response mode conditions and measurement periods, students had differential changes in A-State during the CAI task. That is, whereas the A-State scores of students in the Reading groups decreased during the task, the A-State scores of students in the Constructed Response groups tended to increase. In addition, post hoc analysis revealed that all groups had significant decreases in state anxiety following either the Curiosity-Stimulating or No Instructions conditions.

Another finding of interest was that dependent on levels of A-Trait, response modes, and measurement periods, students had differential A-State scores during the CAI task. That is, high and low A-Trait students in the Constructed Response groups had the same pattern of increases and decreases in A-State; whereas high A-Trait students in the Reading groups had steady decreases in A-State during the CAI task, and low A-Trait students in the Reading groups had increases in A-State during the remaining technical learning materials. Finally, there were no significant effects of response modes or instruction conditions on posttest A-State scores.

Anxiety and Performance Analyses

Effects of Response Mode and Instruction Conditions on Posttest Performance for Low and High A-Trait Students

In order to examine the effects of response modes, instruction conditions, and A-Trait levels on initial and remaining technical posttest performance, two 2 x 2 x 2 analyses of variance were calculated. Independent variables in both analyses were response modes (R, CR), instruction conditions (CSI, NI), and levels of A-Trait (LA, HA). The dependent variable in the first analysis was the mean correct responses on the initial technical portion of the posttest; mean correct responses on the remaining technical portion of the posttest was the dependent variable in the second analysis.

Results of the analysis of variance on the initial technical posttest data presented in Table 23 indicated that students in the Constructed Response groups ($\bar{X} = 22.67$) made significantly more correct responses than students in Reading groups ($\bar{X} = 19.64$). This main effect of response mode conditions was significant at the $p < .001$ level ($F = 26.17$, $df = 1/144$). No other main effects or interactions were significant.

Results of the analysis of variance on the remaining technical posttest data presented in Table 24 revealed no significant main effects or interactions.

Effects of Response Mode and Instruction Conditions on Posttest Performance for Low, Medium, and High A-State Students

In order to investigate the hypothesis that high A-State students would make more incorrect responses on the achievement posttest than low A-State students, two sets of two 2 x 2 x 3 analyses of variance were calculated. The independent variables in both sets of analyses were response modes (R, CR), instruction conditions (CSI, NI), and levels of A-State (low, medium, high). The first set of analyses examined the effects of response mode and instruction conditions on posttest performance as a

TABLE 23

Mean Correct Responses on the Initial Technical Posttest for Low and High A-Trait Students in Response Mode and Instruction Conditions

Groups	A-Trait Level Low	High
Reading - CSI (n=38)		
Mean	19.5	20.47
SD	5.09	3.53
Reading - NI (n=38)		
Mean	19.68	18.90
SD	2.79	3.45
Constructed Response - CSI (n=38)		
Mean	22.95	23.32
SD	4.26	2.54
Constructed Response - NI (n=38)		
Mean	23.00	21.42
SD	2.89	3.92

function of A-State levels during the posttest, whereas the second set of analyses examined the effects of treatment conditions on posttest performance as a function of A-State levels during the CAI learning task.

Although previous CAI research on state anxiety (e.g., Leherissey et al., 1971a; Leherissey et al., 1971b) has shown performance to be more closely related to A-State measures taken during the posttest, an examination of the effects of in-task A-State on posttest performance seems justified on the basis of the possibilities for educational intervention before students are administered an achievement posttest. The dependent variables in both sets of two analyses were: (a) mean correct responses on the initial technical portion of the posttest; and (b) mean correct responses on the remaining technical portion of the posttest.

In the first set of analyses, students were divided into low, medium, and high A-State groups on the basis of their A-State scores on the retrospective STAI A-State measure given immediately after the achievement posttest. This distribution was ranked and divided approximately into thirds. The Reading-CSI, Reading-NI, Constructed Response-CSI, and Constructed Response-NI groups were then separated out of this distribution, yielding an unequal N in each group. The range of low A-State scores was 5-7; medium A-State scores ranged from 8-11; the range of high A-State scores was 12-20.

TABLE 24

Mean Correct Responses on Remaining Technical Posttest for Low and High A-Trait Students in Response Mode and Instruction Conditions

Groups	A-Trait Level Low	 High
Reading - CSI (n=38)		
Mean	32.42	35.58
SD	15.67	18.50
Reading - NI (n=38)		
Mean	36.26	37.47
SD	16.38	17.08
Constructed Response - CSI (n=38)		
Mean	48.63	39.32
SD	15.44	17.08
Constructed Response - NI (n=38)		
Mean	36.79	37.68
SD	17.84	19.34

In the second set of analyses, students were divided into low, medium, and high A-State groups on the basis of their summed scores on the six STAI A-State measures given during the CAI task. This distribution was ranked and divided approximately into thirds. The Reading-CSI, Reading-NI, Constructed Response-CSI, and Constructed Response-NI groups were then separated out of this distribution, yielding an unequal N in each group. The range of low in-task A-State scores was 30-41; medium in-task A-State scores ranged from 42-56; the range of high in-task A-State scores was 57-89.

Posttest A-State analyses. The means and standard deviations of correct responses for the low, medium, and high posttest A-State groups in response mode and instruction conditions on the initial technical and remaining technical posttest are reported in Tables 25 and 26, respectively.

Results of the first set of analyses on the initial technical posttest data presented in Table 25 indicated that students in the Constructed Response groups ($\overline{X} = 22.67$) made significantly more correct responses than students in Reading groups ($\overline{X} = 19.64$). This main effect of response mode conditions was significant at the $p < .001$ level ($F = 29.99$, $df = 1/140$). In addition, there was a significant interaction between instruction conditions and A-State levels ($F = 3.24$, $df = 2/140$, $p < .05$). This interaction is shown in Figure 12, which indicates that whereas there was relatively little difference in the performance of low posttest A-State students in the

TABLE 25

Mean Correct Responses on the Initial Technical Posttest for Low, Medium, and High Posttest A-State Students in Response Mode and Instruction Conditions

Groups	Posttest A-State Level		
	Low	Medium	High
Reading - CSI (n=38)			
Mean	19.92	19.36	20.83
SD	5.45	4.01	3.69
Reading - NI (n=38)			
Mean	19.14	20.27	18.62
SD	3.90	2.41	2.69
Constructed Response - CSI (n=38)			
Mean	24.40	22.61	22.80
SD	1.58	4.27	3.16
Constructed Response - NI (n=38)			
Mean	22.83	24.44	20.59
SD	3.66	1.51	3.45

Curiosity-Stimulating Instructions and No Instructions groups, dependent upon whether medium and high posttest A-State students were in the Curiosity-Stimulating Instructions or No Instructions groups, they responded differentially on the initial technical posttest. That is, high posttest A-State students in the Curiosity- Stimulating Instructions groups performed better than high posttest A-State students in the No Instructions groups, whereas the reverse was true for medium posttest A-State students. No other main effects or interactions were significant.

Results of the first set of analyses on the remaining technical posttest data presented in Table 26 revealed that students in the Constructed Response groups ($\bar{X}$ = 40.16) performed significantly better than students in the Reading groups ($\bar{X}$ = 35.43). This main effect of response modes was significant at the $p < .05$ level (F = 4.13, df = 1/140). No other main effects or interactions were significant.

In-task A-State analyses. The means and standard deviations for the low, medium, and high in-task A-State groups in response mode and instruction conditions on the initial technical and remaining technical posttest are reported in Tables 27 and 28, respectively.

Results of the analysis of variance on the initial technical posttest data presented in Table 27 again revealed that students in the Constructed Response groups ($\bar{X}$ = 22.67) made significantly more correct responses than students in the Reading ($\bar{X}$ = 19.64) groups (F = 26.06, df = 1/140, $p < .001$). In addition, a significant

TABLE 26

Mean Correct Responses on the Remaining Technical Posttest for Low, Medium, and High Posttest A-State Students in Response Mode and Instruction Conditions

Groups	Posttest A-State Level		
	Low	Medium	High
Reading - CSI (n=38)			
Mean	31.17	34.36	36.42
SD	17.07	16.96	17.99
Reading - NI (n=38)			
Mean	34.57	40.00	36.69
SD	18.52	17.16	14.46
Constructed Response - CSI (n=38)			
Mean	51.00	43.00	38.70
SD	11.79	16.57	20.16
Constructed Response - NI (n=38)			
Mean	40.67	42.67	31.94
SD	23.82	8.41	17.27

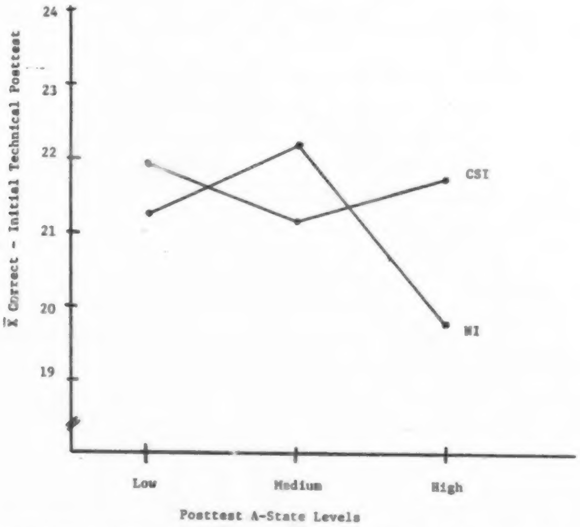


Figure 12.—Instruction conditions by posttest A-State levels interaction on initial technical posttest scores.

TABLE 27

Mean Correct Responses on the Initial Technical Posttest for Low, Medium, and High In-Task A-State Students in Response Mode and Instruction Conditions

Groups	In-Task A-State Level Low	Medium	High
Reading - CSI (n=38)			
Mean	18.81	20.44	21.25
SD	5.90	2.83	2.44
Reading - NI (n=38)			
Mean	18.94	19.58	19.50
SD	3.66	2.71	2.88
Constructed Response - CSI (n=38)			
Mean	24.46	23.15	22.07
SD	1.70	3.02	4.57
Constructed Response - NI (n=38)			
Mean	22.89	23.43	20.67
SD	3.82	2.38	3.77

interaction was found between response modes and A-State levels (F = 3.44, df = 2/140, $p < .05$). This interaction is shown in Figure 13, and indicates that high in-task A-State students in the Reading groups performed better than low in-task A-State students, whereas for the Constructed Response groups the reverse was true. No other main effects or interactions in this analysis were significant.

Results of the analysis of variance on the remaining technical posttest presented in Table 28 revealed no significant main effects or interactions.

To summarize, although A-Trait was not found to be related to posttest performance, the results of the state anxiety and performance data analyses indicated that the hypothesis that high A-State students would make more incorrect responses on the achievement posttest than low A-State students was only partially supported. That is, on the initial technical posttest there was a significant interaction between instruction conditions and levels of posttest A-State. This interaction indicated that whereas instruction conditions did not differentiate the performance of low posttest A-State students, high posttest A-State students in the Curiosity-Stimulating Instructions groups performed better than high posttest A-State students in the No Instructions groups, and medium posttest A-State students in the No Instructions conditions performed better than medium posttest A-State students in the Curiosity-Stimulating Instructions conditions.

TABLE 28

Mean Correct Responses on the Remaining Technical Posttest for Low, Medium, and High In-Task A-State Students in Response Mode and Instruction Conditions

	In-Task A-State Level		
Groups	Low	Medium	High
Reading - CSI (n=38)			
Mean	32.13	34.00	36.31
SD	16.69	22.00	14.42
Reading - NI (n=38)			
Mean	33.94	39.58	38.30
SD	16.76	16.62	17.00
Constructed Response - CSI (n=38)			
Mean	52.18	43.08	38.36
SD	11.17	14.96	20.08
Constructed Response - NI (n=38)			
Mean	40.00	41.21	31.87
SD	22.71	15.61	17.84

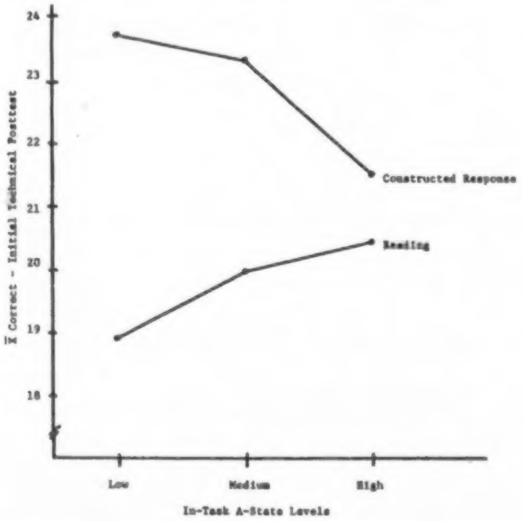


Figure 13.—Response modes by in-task A-State levels interaction on initial technical posttest scores.

When students were divided into low, medium, and high A-State groups on the basis of their summed in-task A-State scores, a significant interaction was found between response modes and levels of in-task A-State. That is, high in-task A-State students in the Constructed Response groups made more incorrect responses on the initial technical and remaining technical posttest than low in-task A-State students in the Constructed Response groups, whereas the reverse was true for low and high in-task A-State students in the Reading groups. In addition, students in the Constructed Response groups were found to make more correct responses on the initial technical portion of the posttest than students in the Reading groups.

Curiosity, Anxiety, and Performance Results

Trait Curiosity and State Anxiety Analyses

Effects of Response Mode and Instruction Conditions on In-Task A-State Scores for Low and High Trait Curious Students

In order to determine the effects of levels of trait curiosity, response modes, and instruction conditions on state anxiety scores during the CAI task, a 2 x 2 x 2 x 6 analysis of variance with repeated measures on the last factor was calculated. Independent variables were response modes (R, CR), instruction conditions (CSI, NI), levels of trait curiosity (LC, HC), and measurement periods (six short form STAI A-State measures). The dependent variable was mean state anxiety scores on the six A-State measures given during the CAI task.

The means and standard deviations of in-task A-State scores for low and high trait curious students in response mode and instruction conditions are reported in Table 29.

Results of the analysis of variance on these data revealed two significant interactions: (a) response modes by levels of trait curiosity, which is plotted in Figure 14 ($F = 4.62$, $df = 1/144$, $p < .05$); and (b) response modes by measurement periods, which is plotted in Figure 10, p. 86, ($F = 11.19$, $df = 5/720$, $p < .001$). As Figure 14 indicates, whereas low trait curious students in the Constructed Response groups had higher A-State scores during the CAI task than high trait curious students in the Constructed Response groups, for low and high trait curious students in the Reading groups, the reverse was true. The interaction, which is plotted in Figure 10, indicates that students in the Constructed Response groups had variable increases in A-State during the CAI learning task, while students in the Reading groups had steady declines in A-State during the CAI task. The main effect of measurement periods was also significant ($F = 12.07$, $df = 5/720$, $p < .001$), indicating that state anxiety scores significantly changed across measurement periods. No other main effects or interactions were significant.

Effects of Response Mode and Instruction Conditions on Posttest A-State Scores for Low and High Trait Curious Students

A 2 x 2 x 2 analysis of variance was calculated to examine the effects of levels of trait curiosity, response modes, and instruction conditions on A-State scores during the achievement posttest. The independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), and levels of trait curiosity (LC, HC).

TABLE 29

Mean A-State Scores on the Six In-Task STAI A-State Measures
for Low and High Trait Curious Students in Response
Mode and Instruction Conditions

		Measurement Periods					
	Groups	Pre CSI/NI	Post CSI/NI	Post T_I1	Post T_I2	Post T_R1	Post T_R2
	All groups (N=152)						
	Mean	9.70	7.95	8.90	8.16	8.38	8.17
	SD	3.39	2.82	3.23	3.27	3.36	3.37
Reading–CSI	LC (n=19)						
	Mean	10.37	8.84	8.26	8.26	7.73	7.68
	SD	3.98	3.16	3.23	3.70	3.35	2.87
	HC (n=19)						
	Mean	10.00	8.47	8.26	6.63	7.00	7.11
	SD	3.87	3.01	3.52	1.95	2.21	2.51
Reading–NI	LC (n=19)						
	Mean	8.94	6.90	7.47	7.16	6.95	6.95
	SD	3.39	2.49	2.76	2.69	3.34	2.55
	HC (n=19)						
	Mean	10.16	9.47	8.63	8.47	8.11	7.63
	SD	3.52	2.99	2.85	3.49	3.28	2.52
Constructed Response–CSI	LC (n=19)						
	Mean	9.79	7.47	10.26	9.42	9.90	9.32
	SD	2.80	2.22	3.80	3.76	3.56	3.54
	HC (n=19)						
	Mean	9.05	6.84	8.79	7.58	7.90	8.26
	SD	3.08	1.95	2.49	2.29	2.36	3.71
Constructed Response–NI	LC (n=19)						
	Mean	10.53	8.95	10.32	9.63	10.11	9.84
	SD	3.49	3.03	2.81	3.69	3.78	4.45
	HC (n=19)						
	Mean	8.74	6.68	9.16	8.11	9.32	8.53
	SD	2.96	2.43	3.61	3.48	4.31	3.63

The dependent variable was mean A-State scores on the retrospective STAI A-State measure given after the achievement posttest.

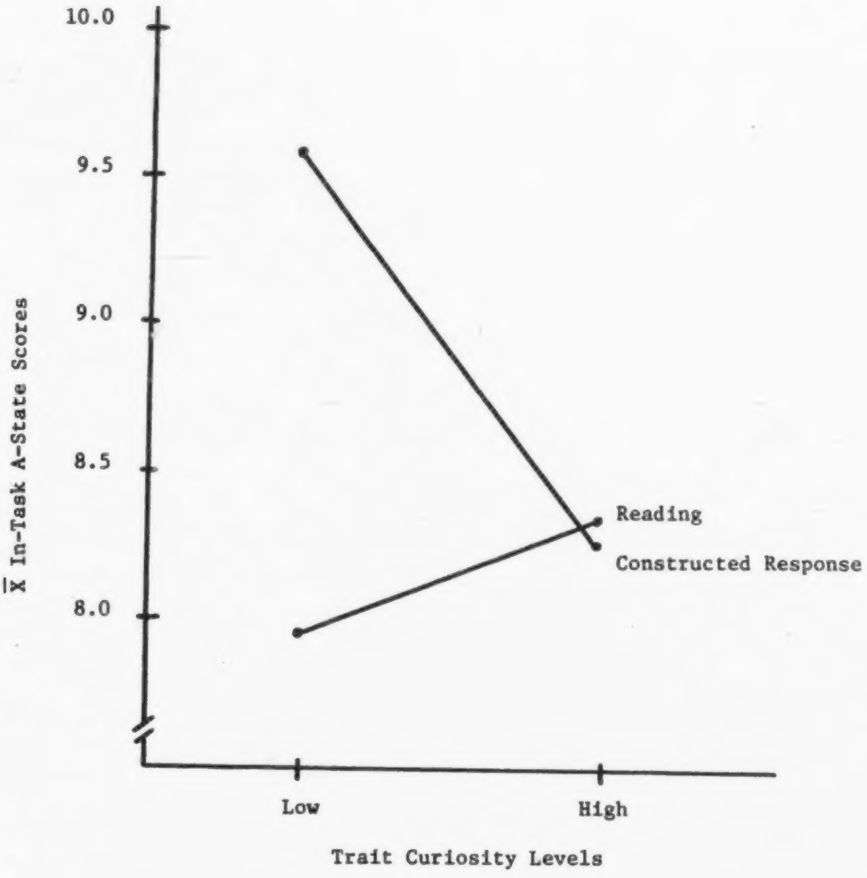


Figure 14.—Response modes by trait curiosity levels interaction on in-task A-State scores.

The means and standard deviations of posttest A-State scores for low and high trait curious students in response mode and instruction conditions are reported in Table 30.

Results of the analysis of variance on these data revealed no significant main effects or interactions.

In summary, the results of the trait curiosity and state anxiety data analyses indicated that dependent upon levels of trait curiosity and response mode conditions, students had differential state anxiety scores during the CAI task. That is, low trait curious students in the Constructed Response groups had higher state anxiety scores than high trait curious students in the Constructed Response groups; in contrast, for

TABLE 30

Mean STAI A-State Scores on the Posttest A-State Measure for Low and High Trait Curious Students in Response Mode and Instruction Conditions

Groups	Trait Curiosity Levels	
	Low	High
Reading - CSI (n=38)		
Mean	11.05	9.68
SD	5.29	3.79
Reading - NI (n=38)		
Mean	9.32	10.00
SD	3.99	3.62
Constructed Response - CSI (n=38)		
Mean	10.26	8.6[illegible]
SD	4.32	2.94
Constructed Response - NI (n=38)		
Mean	11.21	9.90
SD	4.38	4.70

students in the Reading groups, low trait curious students were found to have lower state anxiety during the CAI task than high trait curious students. Students in the Reading groups were also found to have steady decreases in state anxiety scores during the CAI task, whereas students in the Constructed Response groups had variable increases in state anxiety. No effects of trait curiosity, response modes, or instruction conditions were found on the state anxiety scores during the achievement posttest.

Trait Anxiety and State Curiosity Analyses

Effects of Response Mode and Instruction Conditions on In-Task State Curiosity Scores for Low and High Trait Anxious Students

In order to investigate the effects of trait anxiety and treatment variables on in-task state curiosity scores, a 2 x 2 x 2 x 6 analysis of variance with repeated measures on the last factor was calculated. The independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), levels of A-Trait (LA, HA), and measurement periods (six in-task state curiosity measures). The cut-off scores for the low and high A-Trait groups corresponded to the upper and lower thirds of the published A-Trait norms for college undergraduate females (Spielberger et al., 1970). The dependent variable in this analysis was mean state curiosity scores on the six short form SECS scales given during the CAI learning task.

The means and standard deviations of the low and high A-Trait students in response mode and instruction conditions on the six in-task SECS measures are given in Table 31.

TABLE 31

Mean State Curiosity Scores on Six In-Task SECS Measures for Low and High A-Trait Students in Response Mode and Instruction Conditions

		Measurement Periods					
	Groups	Pre Instructions	Post Instr.	Post T_I1	Post T_I2	Post T_R1	Post T_R2
	All groups (N=152)						
	Mean	24.21	24.20	24.41	22.31	22.49	20.30
	SD	3.14	3.45	3.77	4.97	5.04	5.84
Reading–CSI	LA (n=19)						
	Mean	25.11	25.68	26.53	22.63	24.80	22.16
	SD	2.87	2.54	1.84	5.19	4.73	5.50
	HA (n=19)						
	Mean	23.37	23.53	23.53	24.79	22.47	20.53
	SD	2.57	3.50	3.78	4.43	4.48	5.72
Reading–NI	LA (n=19)						
	Mean	24.42	24.47	24.42	22.63	22.74	21.63
	SD	2.74	2.59	3.06	4.68	4.23	5.38
	HA (n=19)						
	Mean	23.53	23.32	25.37	22.00	23.21	21.95
	SD	3.27	3.85	3.53	5.13	3.99	4.86
Constructed Response–CSI	LA (n=19)						
	Mean	25.26	24.53	23.79	22.90	23.05	20.32
	SD	2.31	3.41	3.68	3.73	3.84	5.50
	HA (n=19)						
	Mean	23.32	23.47	23.00	21.79	19.90	17.58
	SD	4.16	4.34	4.63	5.09	5.38	5.96
Constructed Response–NI	LA (n=19)						
	Mean	24.16	24.58	24.26	23.11	22.11	19.47
	SD	3.83	3.85	4.63	4.78	6.67	6.82
	HA (n=19)						
	Mean	24.53	24.05	24.37	21.63	21.58	18.79
	SD	2.86	3.10	3.82	6.89	5.77	6.25

The results of the analysis of variance on these data revealed a significant interaction between response modes and measurement periods, which is shown in Figure 4 ($F = 5.16$, $df = 5/720$, $p < .05$). This interaction indicates that students in the Constructed Response groups had a steady decrease in state curiosity during the task, whereas students in the Reading groups had variable increases and decreases in state curiosity. The main effect of measurement periods was also significant in this analysis at the $p < .001$ level ($F = 43.26$, $df = 5/720$), indicating that state curiosity scores significantly decreased during the CAI task for all groups. No other main effects or interactions approached significance.

Effects of Response Mode and Instruction Conditions on Pre and Posttask State Curiosity Scores for Low and High Trait Anxious Students

In order to examine whether there were significant differences between groups on the pre and posttask state curiosity scores, as measured by the 20-item SECS scales, a 2 x 2 x 2 x 2 analysis of variance with repeated measures on the last factor was calculated. The independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), levels of A-Trait (LA, HA), and measurement periods (Pretask, Posttask). The dependent measure was mean state curiosity scores on the pre and posttask SECS scales.

The means and standard deviations of pre and posttask state curiosity scores for low and high A-Trait students in response mode and instruction conditions are presented in Table 32.

Results of the analysis of variance on these data indicated that all groups had significantly higher state curiosity scores on the pretask SECS given prior to the experimental session ($\bar{X} = 62.67$) than on the posttask measure ($\bar{X} = 58.61$). This main effect of measurement periods was significant at the $p < .001$ level ($F = 18.49$, $df = 1/144$). No other main effects or interactions approached significance.

To summarize, the results of the trait anxiety and state curiosity data analyses indicated that levels of state curiosity changed over time, in that all groups were found to have highest levels of curiosity at the beginning of the CAI task, decreases in curiosity throughout the task, and lowest levels of state curiosity at the end of the CAI task. The results of the pre and posttask state curiosity analysis indicated that all groups had higher levels of state curiosity on the pretask measure than on the posttask measure. In addition, dependent upon response mode condition and measurement period, students had differential changes in state curiosity across time. That is, for students in the Constructed Response groups, there was a steady decline in in-task state curiosity, whereas students in the Reading groups had variable increases and decreases in in-task state curiosity. However, neither levels of trait anxiety or instruction conditions were found to differentially affect state curiosity scores during the experimental session.

State Curiosity and State Anxiety Analysis

Effects of Response Mode and Instruction Conditions on In-Task A-State Scores for Low, Medium, and High State Curious Students

In order to investigate the hypothesis that high state curious students would have lower levels of state anxiety throughout the experimental task than low state curious

TABLE 32

Mean State Curiosity Scores on the Pre and Posttask SECS Measure for Low and High A-Trait Students in Response Mode and Instruction Conditions

Groups		State Curiosity Measure	
		Pretask	Posttask
Reading–CSI	LA (n=19)		
	Mean	65.63	61.37
	SD	9.84	11.70
	HA (n=19)		
	Mean	60.63	59.58
	SD	6.65	12.47
Reading–NI	LA (n=19)		
	Mean	62.21	56.05
	SD	16.23	17.29
	HA (n=19)		
	Mean	62.32	61.42
	SD	11.21	14.21
Constructed Response–NI	LA (n=19)		
	Mean	64.37	57.32
	SD	7.26	12.70
	HA (n=19)		
	Mean	60.42	56.05
	SD	9.13	12.59
Constructed Response–CSI	LA (n=19)		
	Mean	64.05	59.63
	SD	9.70	15.10
	HA (n=19)		
	Mean	61.68	57.42
	SD	7.23	15.24

students, a 2 x 2 x 3 x 6 analysis of variance with repeated measures on the last factor was calculated. The independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), levels of in-task state curiosity (low, medium, high), and measurement periods (six short form STAI A-State measures). Students were divided into low, medium, and high in-task state curious groups on the basis of their summed scores on the six short form SECS scales given during the CAI task. This distribution was ranked and divided approximately into thirds. The Reading-CSI, Reading-NI, Constructed Response-CSI, and Constructed Response-NI groups were separated out, yielding an unequal N in each group. Low state curiosity scores ranged from 76-130; medium state curiosity scores ranged from 131-150; the range of high in-task state curiosity scores was 151-168. The dependent variable was mean A-State scores on the six A-State measures given during the CAI task.

The means and standard deviations of the six A-State scores for low, medium, and high in-task state curious students in response mode and instruction conditions are reported in Table 33.

Results of the analysis of variance on these data indicated that high in-task state curious students ($\bar{X} = 7.88$) had lower A-State scores throughout the CAI task than medium ($\bar{X} = 8.25$) and low ($\bar{X} = 9.49$) state curious students. This main effect of in-task state curiosity was significant at the $p < .01$ level ($F = 5.76$, $df = 2/140$). In addition, two interactions were significant: (a) response modes by levels of state

TABLE 33

Mean A-State Scores on the Six In-Task STAI A-State Measures for Low, Medium, and High In-Task State Curious Students in Response Mode and Instruction Conditions

		Measurement Periods					
	Groups	Pre CSI/NI	Post CSI/NI	Post T_I1	Post T_I2	Post T_R1	Post T_R2
	All groups (N=152)						
	Mean	9.70	7.95	8.90	8.16	8.38	8.17
	SD	3.68	3.16	3.13	3.08	3.17	3.27
Reading—CSI	Low (n=10)						
	Mean	12.20	10.50	9.90	9.30	7.90	8.10
	SD	4.16	3.21	4.04	3.71	3.25	2.38
	Medium (n=15)						
	Mean	10.07	8.27	7.80	6.87	6.93	7.20
	SD	3.41	2.38	2.83	2.50	2.87	3.08
	High (n=13)						
	Mean	8.77	7.69	7.54	6.69	7.46	7.08
	SD	3.77	3.23	3.10	2.59	2.57	2.50
Reading—NI	Low (n=10)						
	Mean	9.80	7.90	8.10	8.50	7.70	7.70
	SD	4.08	3.54	2.64	3.84	3.56	3.23
	Medium (n=15)						
	Mean	9.67	8.33	7.60	7.00	7.13	6.60
	SD	3.35	3.16	3.38	2.73	2.43	1.68
	High (n=13)						
	Mean	9.23	8.23	8.54	8.23	7.85	7.77
	SD	3.35	2.62	2.37	3.06	2.97	2.74

Table 33 continued on next page

TABLE 33 (Continued)

	Groups	Measurement Periods Pre CSI/NI	Post CSI/NI	Post T_I1	Post T_I2	Post T_R1	Post T_R2
Constructed Response–CSI	Low (n=16)						
	Mean	10.12	8.19	10.31	9.63	10.37	9.63
	SD	2.31	1.80	3.01	3.24	3.26	3.36
	Medium (n=10)						
	Mean	8.30	7.10	10.50	8.20	8.70	9.90
	SD	3.92	2.60	3.57	3.23	1.70	4.43
	High (n=12)						
	Mean	9.42	5.83	7.67	7.25	7.08	6.75
	SD	2.68	1.12	2.71	2.86	3.09	2.42
Constructed Response–NI	Low (n=15)						
	Mean	9.20	7.80	10.87	10.33	11.60	9.87
	SD	3.08	2.54	3.70	3.83	4.14	4.60
	Medium (n=10)						
	Mean	10.40	8.10	9.40	8.00	8.80	9.80
	SD	3.89	3.35	2.32	2.83	3.05	4.24
	High (n=13)						
	Mean	9.54	7.62	8.69	7.85	8.23	7.92
	SD	3.28	3.25	3.09	3.58	3.92	3.17

curiosity by measurement periods ($F = 2.12$, $df = 10/700$, $p < .05$), and (b) response modes by measurement periods ($F = 14.73$, $df = 5/700$, $p < .001$). The first interaction is plotted in Figure 15, and indicates that low, medium, and high in-task state curious students in response mode conditions had differential changes in A-State throughout the CAI task. That is, although high state curious students in the Constructed Response groups had lower levels of A-State across measurement periods than medium and low state students in the Constructed Response groups, the medium state curious students in the Reading groups had lower levels of A-State across measurement periods than high and low state curious students. The response modes by measurement periods interaction was discussed in the previous section and can be seen in Figure 10. No other main effects or interactions were significant in this analysis.

Effects of Response Mode and Instruction Conditions on Posttest A-State Scores for Low, Medium, and High State Curious Students

In order to determine whether high state curious students would have lower levels of state anxiety during the achievement posttest than low state curious students, a 2 x 2 x 3 analysis of variance was calculated. Independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), and levels of in-task state curiosity (low, medium, high). The dependent variable was mean A-State scores on the short form STAI A-State scale given after the achievement posttest.

The means and standard deviations of posttest A-State scores for low, medium, and high in-task state curious students in response mode and instruction conditions are reported in Table 34.

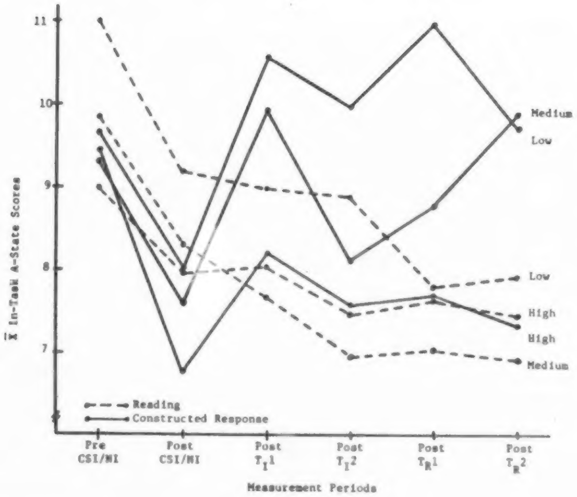


Figure 15.–Response modes by levels of in-task state curiosity by measurement periods interaction on in-task A-State scores.

TABLE 34

Mean A-State Scores on the Posttest STAI A-State Measure for Low, Medium, and High In-Task State Curious Students in Response Mode and Instruction Conditions

Groups	In-Task State Curiosity Levels		
	Low	Medium	High
Reading - CSI (n=38)			
Mean	12.40	9.13	10.23
SD	4.81	3.44	5.33
Reading - NI (n=38)			
Mean	9.30	9.60	10.00
SD	4.03	3.18	4.43
Constructed Response - CSI (n=38)			
Mean	10.88	10.10	7.08
SD	3.36	4.28	2.64
Constructed Response - NI (n=38)			
Mean	11.40	11.70	8.69
SD	5.05	4.81	3.23

Results of the analysis of variance on these data revealed no significant main effects or interactions.

Since the posttask state curiosity scale was given closer in time to the achievement posttest and might, therefore, be expected to be more closely related to A-State scores during the posttest, a second 2 x 2 x 3 analysis of variance was calculated. The independent variables were response modes (R, CR), instruction conditions (CSI, NI), and levels of posttask state curiosity (low, medium, high). Students were divided into low, medium, and high posttask state curious groups on the basis of their scores on the 20-item SECS measure given at the end of the experimental session. This distribution was ranked, divided into thirds, and the Reading-CSI, Reading-NI, Constructed Response-CSI, and Constructed Response-NI groups separated out, which yielded an unequal N in each group. The range of low posttask state curiosity scores was 26-53; medium posttask state curiosity scores ranged from 54-67; the range of high posttask state curiosity scores was 68-80. The dependent variable in this analysis was again mean A-State scores on the short form STAI scale given after the achievement posttest.

The means and standard deviations of posttest A-State scores for low, medium, and high posttask state curious students in response mode and instruction conditions are reported in Table 35.

TABLE 35

Mean A-State Scores on the Posttest STAI A-State Measure for Low, Medium, and High Posttask State Curious Students in Response Mode and Instruction Conditions

Groups	Posttask State Curiosity Levels		
	Low	Medium	High
Reading - CSI (n=38)			
Mean	9.50	10.67	10.69
SD	4.06	4.70	5.09
Reading - NI (n=38)			
Mean	8.73	10.83	8.44
SD	4.08	3.50	3.61
Constructed Response - CSI (n=38)			
Mean	11.88	8.46	6.67
SD	3.48	2.88	2.69
Constructed Response - NI (n=38)			
Mean	12.50	10.75	8.75
SD	5.26	4.37	3.28

Results of the analysis of variance on these data indicated that high posttask state curious students ($\bar{X} = 8.84$) had lower posttest A-State scores than medium ($\bar{X} = 10.20$) or low ($\bar{X} = 10.90$) posttask state curious students. This main effect of posttask state curiosity was significant at the $p < .05$ level ($F = 3.18$, $df = 2/140$). In addition, dependent upon response mode condition and level of posttask state curiosity, students had differential posttest A-State scores ($F = 5.33$, $df = 2/140$, $p < .01$). This interaction is plotted in Figure 16, and indicates that in the Constructed Response groups, low posttask state curious students had higher posttest A-State scores than medium and low posttask state curious students, whereas in the Reading groups medium posttask state curious students had higher posttest A-State scores than high and low posttask curious students. No other main effects or interactions were significant.

In summary, the results of the state curiosity and state anxiety analyses supported the hypothesis that high state curious students would have lower levels of state anxiety throughout the experimental session than low state curious students. That is, high in-task state curious students had lower A-State scores during the CAI task, and high posttask state curious students had lower A-State scores during the achievement posttest, than low state curious students. Students were also found to have differential state anxiety scores dependent upon levels of state curiosity, response mode conditions, and in-task measurement periods. This interaction indicated that in the Constructed Response groups, high state curious students had lower levels of state anxiety than medium and low state curious students, whereas in the Reading groups, medium state curious students had lower levels of state anxiety than high and low state curious students. Finally, although there were no significant effects of treatment conditions or levels of in-task state curiosity on the posttest A-State scores, levels of posttask state curiosity interacted with response mode conditions on posttest A-State scores. That is, whereas there was an inverse relationship between levels of posttask state curiosity and posttest A-State scores for students in the Constructed Response groups, for students in the Reading groups, medium posttask state curious students had higher posttest A-State scores than high and low posttask state curious students.

Integration of Curiosity, Anxiety, and Performance Analyses Within the Framework of the Optimal Degree of Arousal Model

The following section will attempt an integration of the data presented thus far within the theoretical framework of predictions derived from the One Factor and Two Factor versions of the Optimal Degree of Arousal conceptualizations presented earlier (see pages 13-16). These data will be categorized into data relevant to: (a) Predicted Relationships between Curiosity and Anxiety; (b) Predicted Existence and Ordering of Curiosity/Anxiety Categories; and (c) Predicted Relationships between Curiosity, Anxiety, and Performance.

Statistical analyses were not computed for the reported state curiosity and state anxiety data because of the small number of subjects falling into the four possible curiosity/anxiety categories. It should be noted that subjects were matched on trait curiosity and trait anxiety scores, and thus when broken down into the four curiosity/anxiety categories, cell frequencies were more nearly comparable, ranging from 8 to 11 subjects per cell. However, since the low/high categories presuppose extreme scores on the respective curiosity or anxiety inventories, this results in a methodological problem for the trait curiosity groups in that these low and high groups were derived on the basis of a median split. Trait anxiety groups, in contrast, corresponded to the upper and lower thirds of the normative STAI A-Trait distribution for female undergraduates (Spielberger et al., 1970). Thus, a possible masking of trait curiosity effects may exist in the data reported, and these data are intended to be merely suggestive of predicted theoretical relationships.

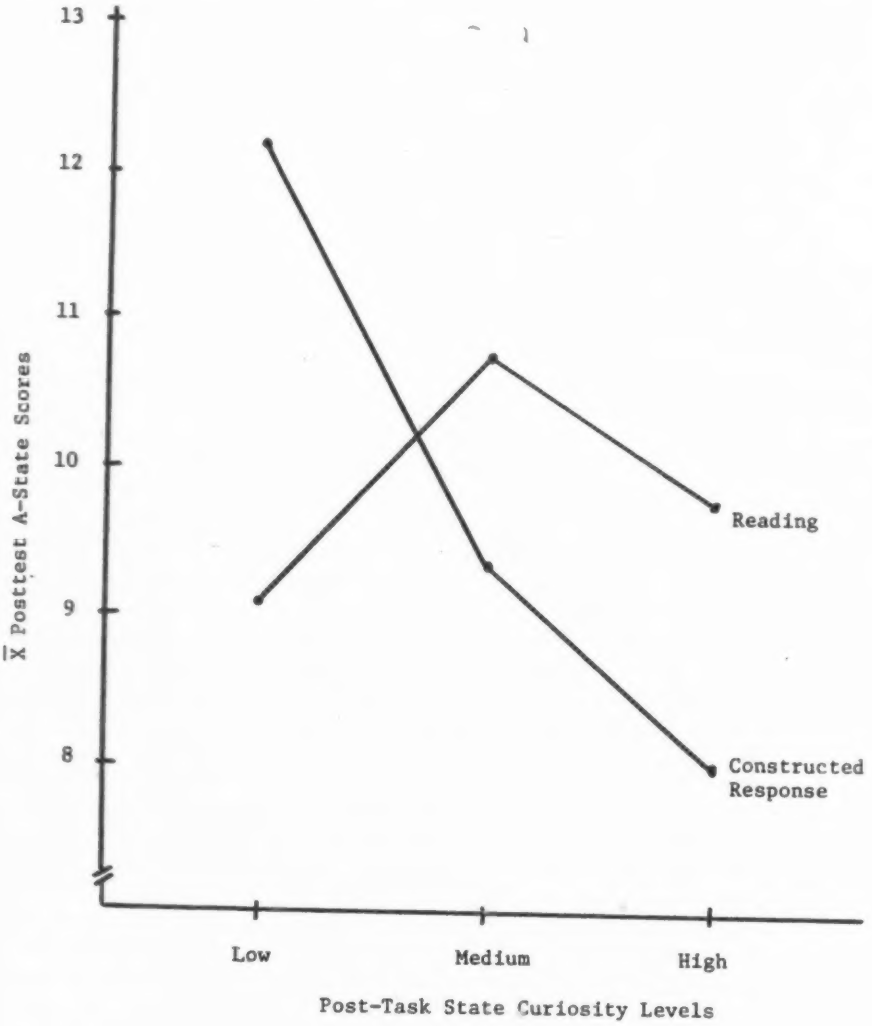


Figure 16.—Response modes by post-task state curiosity levels interaction on posttest A-State scores.

Predicted Relationships Between Curiosity and Anxiety

Differential predictions of the One and Two Factor Models regarding relationships between curiosity and anxiety can be only partially examined with the present data, in that only state measures of specific curiosity relevant to the One Factor Model predictions are available. In order to investigate the predicted relationships between curiosity and anxiety derived from the Two Factor Model, measurements of state diversive curiosity are required. Thus, any data supportive of the Two Factor Model will be indirect.

It should be recalled that the One Factor Model predicts an inverse relationship between state specific curiosity and state anxiety. The evidence collected in the present study relevant to this prediction includes: (a) correlational data between SECS measures and STAI A-State measures; and (b) analyses of variance data in which students were blocked on in-task state curiosity scores to examine the effects of state curiosity on the dependent variable of in-task state anxiety scores. The data from both these sources support the expected inverse relationship between state specific curiosity and state anxiety in that significant negative correlations were found between these two states; and in addition, high state specific curiosity groups were found to have significantly lower state anxiety scores throughout the task than low state specific curiosity groups.

Further data relevant to the predicted inverse relationship between curiosity and anxiety takes into account fluctuations in either of these states as a function of their trait counterparts. Consistent with the assumptions of both the One Factor and Two Factor Models is the concept that persons high in trait curiosity would be expected to experience state curiosity reactions more frequently and intensely than persons low in trait curiosity. On the other hand, persons high in trait anxiety would be expected to experience state anxiety reactions more frequently and intensely than persons low in trait anxiety (Spielberger, 1966; Spielberger et al., 1970). To date, however, there have been no experimental attempts to interrelate the concepts of trait curiosity and trait anxiety with the concepts of state curiosity and state anxiety; and thus, it is instructive to compare these variables in relation to state specific curiosity and state anxiety measured in the present study.

The relationships between trait curiosity, trait anxiety, in-task measurement periods, and state curiosity are shown in Figure 17. This figure represents an integration of the findings of two separate analyses of variance which blocked on either trait curiosity or trait anxiety, respectively. As can be seen in Figure 17, high trait curiosity groups were found to exhibit state curiosity reactions more intensely than low trait curiosity groups, as evidenced by the significantly higher state curiosity scores during the CAI task for the high trait curiosity group. Although the relationship between levels of trait anxiety and state curiosity did not reach significance, it can be noted that the low trait anxiety group had consistently higher state curiosity scores during the CAI task than the high trait anxiety group. Thus, similar findings of an inverse relationship between state specific curiosity and state anxiety were suggested between state specific curiosity and trait anxiety.

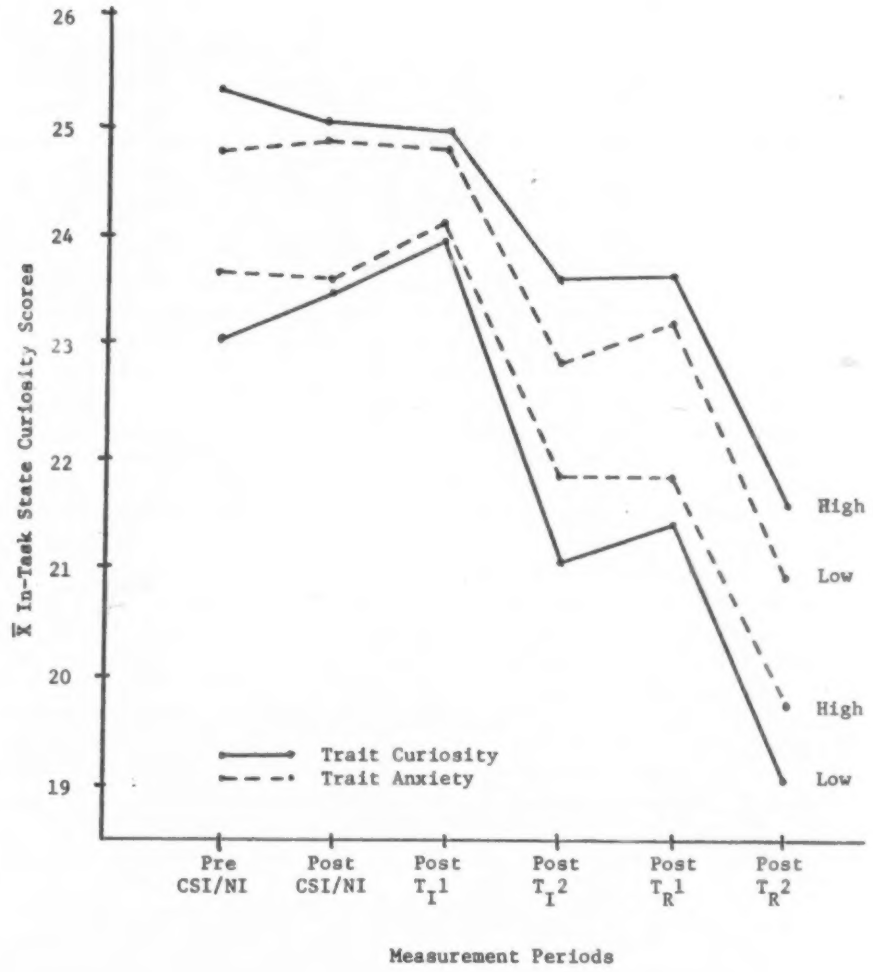


Figure 17.–Relationship between trait curiosity, trait anxiety, in-task measurement periods and state curiosity.

In examining the relationships between trait curiosity, trait anxiety, in-task measurement periods, and state anxiety, plotted in Figure 18, analogous relationships between these variables and those shown in Figure 17 can be noted. For example, confirmation of the predicted relationship between trait anxiety and state anxiety is provided by the significant finding that high trait anxious groups had higher levels of state anxiety during the CAI task than low trait anxious groups. Furthermore, low trait curious groups had consistently higher state anxiety scores throughout the task than

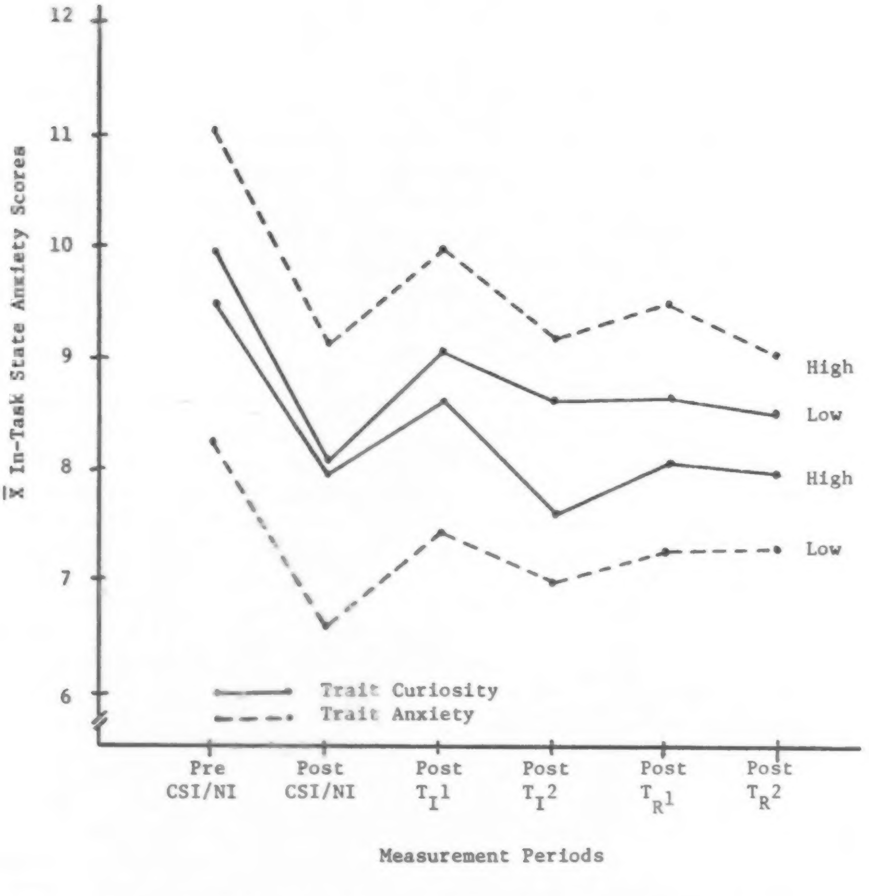


Figure 18.—Relationship between trait curiosity, trait anxiety, in-task measurement periods and state anxiety.

high trait curious groups, although this relationship did not approach significance. Therefore, as in the case of the prior comparison between trait curiosity, trait anxiety, and in-task state curiosity scores, an inverse relationship can be detected between trait anxiety and state specific curiosity scores in the present study.

Indirect evidence of possible relationships between diversive curiosity and anxiety, derived from the Two Factor Model, can be found in the correlational data between measures of trait diversive curiosity (i.e., the SSS and OTIM Diversive Curiosity Subscale) and STAI A-State measures used in the present study. As reported in an earlier section, the correlations between the SSS and A-State scales ranged from -.04 to .17, with only one correlation being significant in a positive direction (i.e., r = .17,

$p < .05$). In addition, the correlations between the A-State scales and the Diversive Curiosity Subscale of the OTIM were found to be nonsignificant, ranging from -.04 to .10. A stronger, more consistent negative relationship, however, was found between the trait measure of specific curiosity (OTIM) and STAI A-State measures (i.e., correlations ranging from -.10 and -.15). These findings, in combination with the finding that the SSS and state specific curiosity scales were not found to correlate significantly (i.e., r's = -.07 to .04), whereas significant correlations were found between the OTIM and SECS scales (i.e., r's = .16 to .52), suggests that the construct of trait diversive curiosity is less related to state anxiety and state specific (epistemic) curiosity than trait specific curiosity. In order to empirically validate the negative relationship between state diversive curiosity and state anxiety predicted by the Two Factor Model, however, concomitant measurements of state diversive curiosity and state anxiety are required.

Predicted Existence and Ordering of Curiosity/Anxiety Categories

Partial evidence of the differential curiosity/anxiety categories predicted by the One Factor and Two Factor Models is provided by an examination of the number of students in the present study who fell into the following possible categories: (a) low state specific curiosity/ low state anxiety; (b) high state specific curiosity/low state anxiety; (c) low state specific curiosity/high state anxiety; and (d) high state specific curiosity/high state anxiety. (Note: This frequency data represents only those students who were in the extremes of both the state curiosity and state anxiety measures.) On the assumption that state specific (epistemic) curiosity is associated with intermediate levels of arousal, the ordering of categories predicted by the One Factor Model corresponds to that given above. In contrast, the Two Factor Model assumes that both state specific curiosity and state anxiety are associated with high levels of arousal, and thus relatively few persons would be expected in the category of low state specific curiosity/high state anxiety.

On the basis of the data collected in the present study, the frequency of persons falling into one of the four possible curiosity/anxiety categories differed markedly for the Constructed Response and Reading groups. Figure 19 shows the number of students in the Constructed Response groups who fell into the ordering of categories predicted by the One Factor Model. As can be noted in Figure 19, the largest number of students were found in the low state specific curiosity/high state anxiety and high state specific curiosity/low state anxiety categories, whereas the fewest number of students were found in the low state specific curiosity/ low state anxiety and high state specific curiosity/high state anxiety categories. These findings are consistent with the inverse relationship between state specific curiosity and state anxiety predicted by the One Factor Model.

On the other hand, the frequency data for the Reading groups more closely approximated the category ordering predictions derived from the Two Factor Model, particularly for the Reading group given Curiosity- Stimulating Instructions. These data are shown in Figure 20, which indicates, as predicted, that fewer students tended to be found in the low state specific curiosity/high state anxiety category relative to the other curiosity/anxiety categories. However, dependent upon whether students in the Reading groups were in the Curiosity-Stimulating or No Instructions conditions,

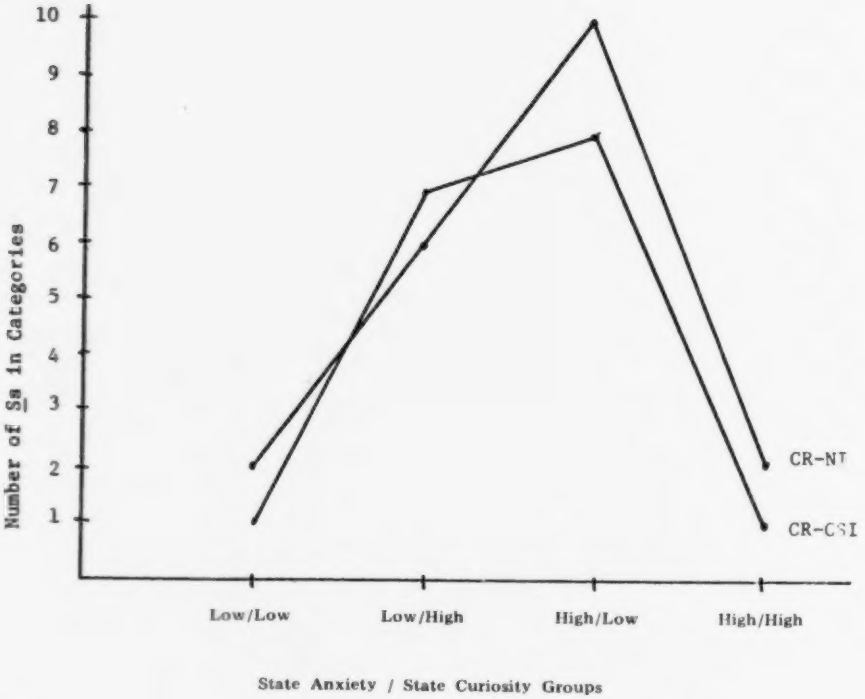


Figure 19.--Frequency of students in the CR groups falling into state anxiety/state curiosity categories.

differential frequency functions were found. In relating this data to the predictions of the Two Factor Model, it should be recalled tht the assumption was made (Spielberger & Butler, 1971) that the predicted relationships between state specific curiosity and state anxiety would occur under conditions of moderate to high stimulus intensity. Since it could be argued that the Reading condition was less arousing (i.e., the task was less complex because overt responding was not required) than the Constructed Response condition, these findings supportive of the Two Factor Model are somewhat tenuous.

Predicted Relationships Between Curiosity, Anxiety, and Performance

In clarifying the relationships between curiosity, anxiety, and performance, it is instructive to separately examine the effects of trait variables and the effects of state variables on posttest performance. Therefore, the data supportive of the One Factor or Two Factor Models are examined first, as a function of trait curiosity and trait

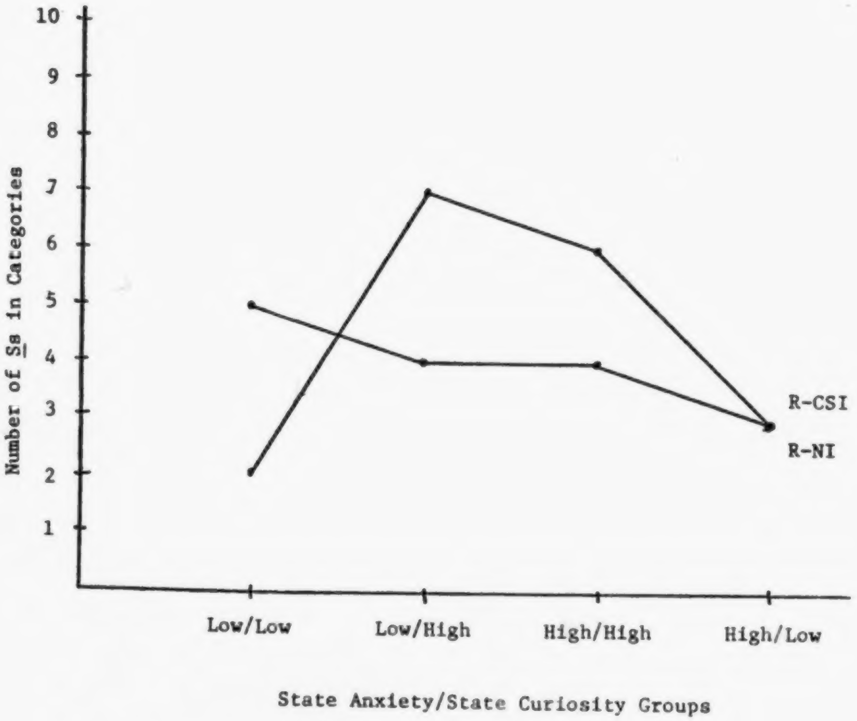


Figure 20.–Frequency of students in the R groups falling into state anxiety/state curiosity categories.

anxiety; and second, as a function of state curiosity and state anxiety. The data are also examined separately for the initial technical and remaining technical portions of the achievement posttest.

It should be recalled that the One Factor Model predicts superior performance for persons in the category of high state specific curiosity/low state anxiety, and inferior performance for students in the category of high state specific curiosity/high state anxie[illegible]trast, the Two Factor Model predicts superior performance for persons i[illegible] state specific curiosity/high state anxiety category relative to other possible categories. The data testing these predictions for the initial technical and remaining technical posttest as a function of trait curiosity and trait anxiety categories are presented in Figures 21 and 22, respectively.

As Figure 21 indicates, with the exception of the Constructed Response-CSI group, students in the high curiosity/high anxiety and high curiosity/low anxiety categories tended to perform better on the initial technical posttest than students in the low curiosity/low anxiety and low curiosity/high anxiety groups. Thus, an inverted-U relationship was approximated between performance and curiosity/anxiety categories,

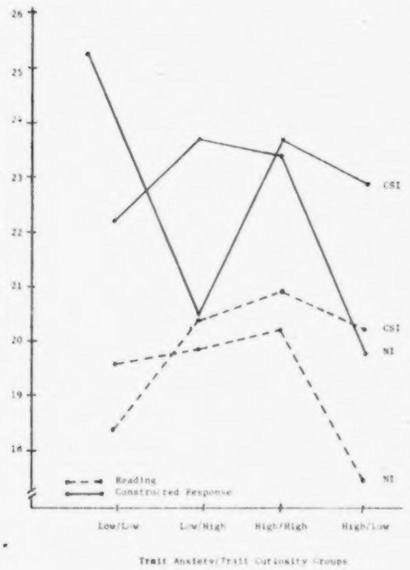


Figure 21.—Relationships between trait anxiety/ trait curiosity categories, response modes, instruction conditions and initial technical posttest performance.

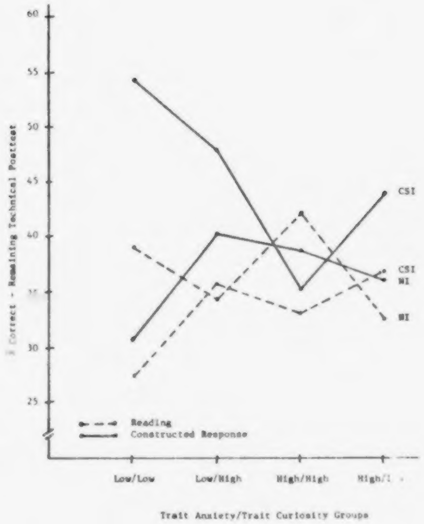


Figure 22.—Relationships between trait anxiety/ trait curiosity categories, response modes, instruction conditions and remaining technical posttest performance.

for all but the Constructed Response-CSI group, in the direction predicted by the Two Factor Model, in that highest levels of performance were found for the high curiosity/high anxiety category relative to the other curiosity/anxiety categories. Although students in the high curiosity/high anxiety in the Constructed Response-CSI group also tended to have facilitated performance, low curiosity/low anxiety students in this group were found to perform better than any of the other categories; and high curiosity/low anxiety students had the lowest levels of performance on the initial technical posttest.

With respect to the remaining technical posttest data plotted in Figure 22, no clearly discernable inverted-U shaped function for the response mode and instruction groups predicted by the One Factor or Two Factor Models is evident, with the exception of the Constructed Response-NI group. As predicted by the One Factor Model, high curiosity/low anxiety students in the Constructed Response-NI group performed better than students in the remaining curiosity/anxiety categories. Supportive of the Two Factor Model predictions is the finding that high curiosity/high anxiety students in the Reading-NI groups performed best relative to the other curiosity/anxiety categories. Contrary to the predictions of either the One Factor or Two Factor Models are the findings that (a) low curiosity/low anxiety students in the Constructed Response-CSI and (b) low curiosity/high anxiety students in the Reading-CSI groups had superior performance relative to the other curiosity/anxiety categories. In interpreting these findings, however, it should be kept in mind that the stimulus-arousing properties of the Reading and Constructed Response conditions were low or high, respectively; and, in addition, the effects of the Curiosity-Stimulating Instructions condition were differential for the Reading and Constructed Response groups. That is, whereas students in the Reading-CSI condition were found to make fewer correct responses on the remaining technical posttest than students in the Reading-NI condition, the reverse was found for students in the Constructed Response groups.

The data which describes the relationships between state curiosity, state anxiety, and posttest performance were plotted as a function of the mean scores for students in the low, medium, and high state curiosity and state anxiety groups. Because of the small number of students in the combined state curiosity/state anxiety categories, the posttest performance data for these groups are plotted separately for the respective state curiosity and state anxiety groups. In addition, the data were examined separately as a function of (a) mean in-task state curiosity and mean in-task state anxiety scores; and (b) mean posttask state curiosity and mean posttest state anxiety scores. Since the data on the initial technical and remaining technical posttest were generally the same, only the data for the initial technical posttest will be discussed. It should be noted that these data cannot directly test the state curiosity and state anxiety relationships to performance predicted by the One Factor and Two Factor Models; however, they are suggestive of these predicted relationships.

The data for low, medium, and high in-task state curiosity and low, medium, and high in-task state anxiety groups on the initial technical posttest are plotted in Figures 23 and 24, respectively. The data for low, medium, and high posttask state curiosity and low, medium, and high posttest state anxiety groups on the initial technical posttest are plotted in Figures 25 and 26, respectively.

As indicated in Figure 23, with the exception of the Reading-CSI group, medium and high state curiosity groups performed considerably better than low state curiosity groups on the initial technical posttest, supporting predictions of superior performance for high state curious students. For students in the Reading-CSI group, however, there was relatively little difference in the performance of low, medium, and high in-task state curiosity groups. The data plotted in Figure 24 as a function of in-task state anxiety indicates that although students in the Constructed Response groups low and medium state anxiety categories performed better than those in the high state anxiety category, for students in the Reading groups the reverse relationship was found.

In integrating the data plotted in Figures 23 and 24, it becomes apparent that an inverse relationship between state curiosity and state anxiety relative to posttest performance is most pronounced for the Constructed Response groups; whereas for the Reading groups, high arousal states of either curiosity or anxiety tend to facilitate performance. A possible interpretation for this effect may again relate to the differential stimulus-arousing properties of the Constructed Response and Reading conditions. That is, because of the less complex nature of the task for students in the Reading groups compared to students in the Constructed Response groups, higher levels of internal arousal states may have enhanced performance in a task that did not invoke high external sources of arousal.

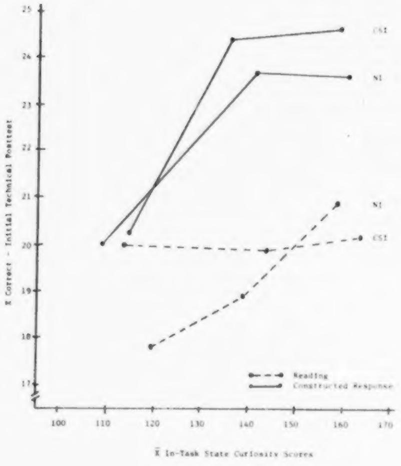


Figure 23.—Relationships between in-task state curiosity, response modes, instruction conditions and initial technical posttest performance.

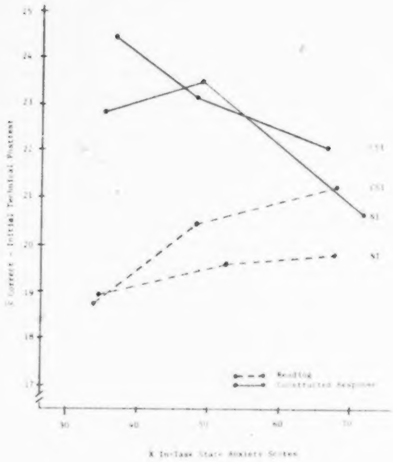


Figure 24.—Relationships between in-task state anxiety, response modes, instruction conditions and initial technical posttest performance.

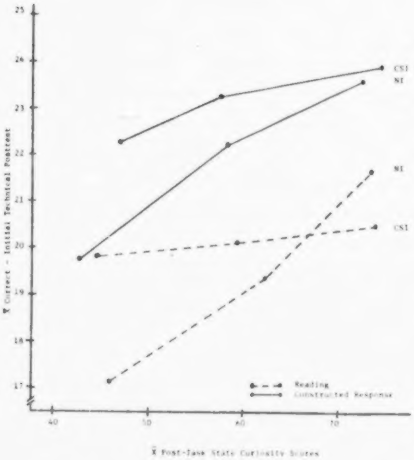


Figure 25.—Relationships between post-task state curiosity, response modes, instruction conditions and initial technical posttest performance.

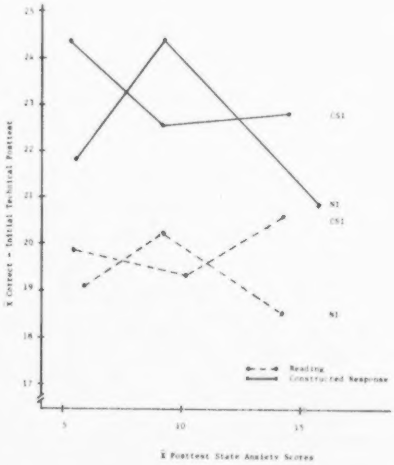


Figure 26.—Relationships between posttest state anxiety, response modes, instruction conditions and initial technical posttest performance.

The posttask state curiosity and posttest state anxiety data plotted in Figures 25 and 26 indicate analogous relationships between curiosity, anxiety, and performance to that shown in Figures 23 and 24, particularly for the data plotted as a function of state curiosity groups (i.e., Figure 23). The initial technical posttest performance data plotted in Figure 26 does reveal some differential findings from that plotted in Figure 24, however. For example, performance of medium posttest A-State students in the Reading-NI group and Constructed Response-NI group was better than that of low and high posttest A-State students in these response mode and instruction conditions. For students in the Constructed Response-CSI group, the expected negative relationship between anxiety and performance was found, with low state anxiety groups performing better than medium and high state anxiety groups on the initial technical posttest. In contrast, for students in the Reading-CSI group, high posttest state anxiety groups performed better than medium or low posttest state anxiety groups. The finding that medium posttest state anxiety groups in the Reading and Constructed Response conditions without Curiosity-Stimulating Instructions tended to perform better than low or high posttest state anxiety groups may possibly be explained by the fact that moderate anxiety states are facilitative in tasks which do not provide external sources of stimulation or arousal, such as provided by the Curiosity-Stimulating Instructions condition.

An integration of the data presented in Figures 25 and 26 suggests that, with the exception of the Reading-CSI group, performance was best under conditions of moderate arousal levels (i.e., medium or high state curiosity and low or medium state anxiety levels). Given the methodological problem of determining the overlap between SECS scores and STAI A-State scores in terms of arousal levels, it is difficult to make any definitive statements on the relationship between optimal levels of arousal and performance. The data are suggestive, however, of predictions derived from the One Factor Model in that viewing the state curiosity and state anxiety scores as lying along an arousal potential continuum, moderate levels of arousal were associated with superior or optimal performance, whereas low or high levels of arousal were associated with inferior performance.

In summary, this section has attempted to integrate the curiosity, anxiety, and performance findings of the present study within the Optimal Degree of Arousal conceptualizations of the One Factor and Two Factor Models. The reader should be reminded that the data presented in this section are speculative and not based on statistical tests of significance. Thus, any inferences supportive of the differential predictions derived from the One Factor or Two Factor Models are tentative and contingent on future research.

With respect to the predicted relationships between curiosity and anxiety, the trait measure of specific curiosity (OTIM) was found to have a stronger and more consistent negative relationship with state anxiety than measures of trait diversive curiosity (SSS and OTIM Diversive Curiosity Subscale). If it can be assumed that these personality traits predict the relative frequency and intensity of their associated state reactions, some indirect support is provided for the predictions of the One Factor Model in that the stronger negative relationship between curiosity and anxiety was found between measures of specific rather than diversive curiosity.

The data presented in support of the differential ordering of curiosity/anxiety categories predicted by the One Factor or Two Factor Models tended to support the predictions of the One Factor Model for the Constructed Response groups, whereas the Reading groups tended to support the predictions of the Two Factor Model. In further speculating on these frequency observations, it seems reasonable to suggest that, in general, the data are more supportive of the categories predicted by the One Factor Model, particularly when the differential stimulus-arousing properties of the Reading and Constructed Response conditions are taken into consideration.

The curiosity, anxiety, and performance data were examined separately as a function of either curiosity and anxiety traits or curiosity and anxiety states. When performance was examined as a function of trait curiosity and trait anxiety, the data supporting the predictions derived from the One and Two Factor Models were differential dependent upon the section of the posttest examined, i.e., initial technical or remaining technical posttest. On the initial technical posttest, high trait curiosity/high trait anxiety groups tended to perform better than the other curiosity/anxiety categories, with the exception of the Constructed Response-CSI group, as predicted by the Two Factor Model. The more highly stimulus-arousing properties of the Constructed Response-CSI condition may have accounted for the superior performance of students in the low trait curiosity/low trait anxiety category in this response mode and instruction condition.

On the remaining technical posttest, the performance of students in the Constructed Response-NI condition was in the direction predicted by the One Factor Model in that superior performance was found for students in the high trait curiosity/low trait anxiety category. In contrast, students in the high trait curiosity/high trait anxiety category in the Reading-NI condition had superior performance relative to other curiosity/anxiety categories, supporting the Two Factor Model predictions. In general, however, the performance data on the remaining technical posttest as a function of the trait curiosity and trait anxiety categories were not clearly supportive of either the One Factor or Two Factor Models. In addition, these findings were largely dependent upon response modes, instruction conditions, and posttest section, suggesting the differential effects of the stimulus-arousing properties associated with these treatment variables.

The data which described the relationships between state curiosity, state anxiety, and performance were more consistent with respect to the posttest sections. That is, these data supported the inverse relationship between curiosity and anxiety predicted by the One Factor Model, with superior performance found for high state curiosity/low state anxiety groups. This relationship was particularly pronounced for the Constructed Response groups, whereas for the Reading groups, high arousal states of either curiosity or anxiety tended to facilitate performance. The interpretation of these findings may again relate to the differential stimulus-arousing properties of the Constructed Response and Reading conditions. In general, however, these data supported the prediction of the One Factor Model, i.e., optimal performance at intermediate levels of arousal.

To adequately examine the theoretical relationships predicted by the Two Factor Model, research employing a state measure of diversive curiosity is required. On the basis of the present findings, however, and the conceptual relationships between the classes of curiosity behaviors, anxiety, and performance, it becomes apparent that refinements and extensions are needed to the predictions of the One Factor and Two Factor Models. Specifically, the One Factor Model does not allow for direct predictions concerning relationships between state diversive curiosity and state specific curiosity, state anxiety, or performance in that this model is concerned with only state specific curiosity and state anxiety on the arousal continuum. Thus, to fully explicate the interactive relationships between the major classes of curiosity behaviors, state anxiety, and performance, an extension of this model is needed.

The Two Factor Model does allow for predictions of the differential relationships between diversive and specific curiosity states, state anxiety and performance; however, the present data imply that some modifications of these predictions are required. For example, (a) no direct predictions of the relationship between state diversive curiosity and state specific curiosity or performance are specified; and (b) the prediction of superior performance for students in the high state specific curiosity/high state anxiety category was only partially confirmed by the present data. It is, therefore, possible to suggest a third model within the Optimal Degree of Arousal concept, which will be discussed in the next chapter.

IV. DISCUSSION

The present study sought to (a) further validate the State Epistemic Curiosity Scale (SECS; Leherissey, 197lb); (b) determine the effects of stimulating state epistemic curiosity on state anxiety and performance in a complex CAI task; and (c) integrate the findings within the theoretical framework of the Optimal Degree of Arousal conceptualization. The results relevant to each of these objectives will be summarized and discussed in the above order.

Validation of the State Epistemic Curiosity Scale

The reliability and validity data collected in the present study are encouraging, in that the SECS was found to have high internal consistency and supportive concurrent and construct validity. The alpha reliability coefficients for the long form (20-item) SECS were found to be .88 and .94 for the pre and posttask scales, respectively. The alpha reliabilities for the short form (7-item) SECS scales ranged from .81 to .93, with the highest alpha reliabilities being found for the SECS scales given during the CAI task rather than those given prior to the task. Thus, the SECS scales were found to be more reliable within the learning situation, reflecting the sensitivity of this state measure of epistemic curiosity to situational factors.

The item-remainder correlations for the individual items of the long and short form SECS scales were found to range from .28 to .87 and .30 to .87, respectively, indicating good predictability for the individual items, particularly within the learning task. In addition, a comparison of the present reliability data with that of previous research with the SECS (Leherissey, 1971b) revealed higher alpha reliabilities for the revised SECS scale used in the present study for comparable measurement periods.

The concurrent validity findings of the present study indicated that, as predicted, the SECS scales, as measures of state specific (epistemic) curiosity, had moderately high positive correlations with the trait measure of specific curiosity, the OTIM, particularly for the pretask SECS measure which could be considered to reflect fewer situational factors. Previous research with the SECS (Leherissey, 1971b) found similar correlations between the SECS and OTIM, and these correlations are within the range of correlations found between trait and state anxiety, as measured by the STAI (Spielberger et al., 1970).

Of considerable interest for both construct validation of the SECS (i.e., verification of the predicted inverse relationship between state curiosity and state anxiety, as specified by the Optimal Degree of Arousal conceptualization) were the significant negative correlations between SECS scores and STAI A-State scores, particularly for those measures taken at the same point in time during the CAI task. In contrast, negligible correlations were found between the measures of trait curiosity (OTIM and SSS) and state anxiety, supporting the importance of a distinction between affective traits and states. Also supportive of predictions derived from the Optimal Degree of Arousal concept were the significant positive correlations between state curiosity and performance on the achievement posttest, which lends credibility to the value of epistemic curiosity states for facilitated performance. On the other hand, the correlations between trait curiosity and posttest performance were negligible, supporting the theoretically predicted efficacy of the SECS.

Further evidence of the construct validity of the SECS and the conceptual distinctions between major classes of curiosity behaviors specified by the Optimal Degree of Arousal conceptualization were the negligible correlations between the SECS scales and measures of diversive curiosity (i.e., the SSS and OTIM Diversive Curiosity Subscale) administered in the present study. As Cronbach and Meehl (1955) have stated concerning construct validation, one can have substantial confidence that an instrument is measuring a particular construct if the associated theory covers the variates which yield positive correlations and does not predict correlations where none are found. Thus, the validity findings with the SECS are consistent with the predictions of the Optimal Degree of Arousal concept, and provide considerable confidence that the SECS is measuring state specific epistemic curiosity as conceptualized in scale development (Leherissey, 1971b).

In general, therefore, the importance of the state concepts of both curiosity and anxiety, as distinct from their trait counterparts, is emphasized by several present validation findings. First, the correlations between trait curiosity and trait anxiety were negligible, indicating that the inverse relationship between curiosity and anxiety was functional for only the state measures used in this study. Second, the failure to find significant negative correlations between trait curiosity and state anxiety suggests that the SECS is a more sensitive measure for ascertaining the conceptual relationship between curiosity and anxiety, as specified by the Optimal Degree of Arousal conceptualization. In addition, the low negative correlations found between trait anxiety and state curiosity further suggest that state measures represent a methodological improvement for specifying the theoretical relationships between curiosity and anxiety.

Finally, the additional findings that students high in either trait curiosity or trait anxiety had higher levels of state curiosity or state anxiety, respectively; and the concomitant finding that these traits or personality predispositions were relatively independent, points to the importance of situational factors in the learning environment. These validation findings imply, therefore, the methodological and conceptual necessity for distinguishing between affective traits and states, particularly as they relate to a theoretical model of differential arousal states which are situation dependent.

Effects of Stimulating State Epistemic Curiosity on State Anxiety and Performance

The experimental findings on the effects of stimulating state epistemic curiosity on state anxiety and performance are best summarized in the order of the hypotheses investigated in the present study. The first group of hypotheses was derived from the Optimal Degree of Arousal conceptualization which predicted relationships between state curiosity, state anxiety, and performance. As predicted, high trait curious students were found to have higher levels of state curiosity throughout the task than low trait curious students. In addition, the hypothesis that levels of state curiosity would change during the experimental session was also supported, i.e., all groups were found to have higher levels of state curiosity prior to the CAI task than during and after the task. Dependent upon whether students were in the Constructed Response or Reading groups, however, their state curiosity scores changed differentially during the CAI task. Whereas students in the Constructed Response groups had steady decreases in state curiosity during the task, students in the Reading groups had variable increases and decreases in state curiosity. The significant interaction between trait curiosity, response modes, and measurement periods further indicated that only high trait curious students in the Reading groups retained a relatively high level of state curiosity throughout the CAI task.

The hypothesis that high state curious students would have lower levels of state anxiety throughout the CAI task and achievement posttest than low state curious students was corroborated, thus providing further evidence of the predicted inverse relationship between state curiosity and state anxiety. The prediction of facilitated performance for students scoring high in state epistemic curiosity relative to those scoring low was also substantiated, in that high state curious students made more correct responses on the initial technical and remaining technical portions of the achievement posttest than low state curious students.

The prediction that students in the Curiosity-Stimulating Instructions group would have higher levels of state curiosity than students in the No Instructions group was not substantiated. In contrast, regardless of whether students were given special instructions designed to increase state epistemic curiosity toward the learning materials or whether they were given a brief rest, levels of state curiosity remained at a relatively high level prior to the CAI task. To interpret this finding, however, several other factors should be taken into consideration. First, the fact that all students had high levels of state curiosity prior to the CAI task may be attributable to the novelty of the CAI experience for a majority of the students in this study, confounding the effect of experimental manipulation of curiosity through special instructions with that of curiosity aroused by the instructional mode and leading to a ceiling effect for initial state curiosity scores. Furthermore, the initial manipulation of curiosity prior to adaptation to a novel learning situation may not have been sufficient to maintain levels of curiosity throughout the learning task. Alternatively, the possibility that the Curiosity-Stimulating Instructions used in the present study were not efficacious for stimulating or maintaining curiosity levels must be considered. To more adequately assess the effects of stimulating curiosity, therefore, additional research is needed on more frequent manipulations through special curiosity-stimulating instructions.

With regard to the hypotheses derived from Trait-State Anxiety Theory (Spielberger, 1966; Spielberger et al., 1970), the hypothesis that high A-Trait students would have higher levels of state anxiety during the CAI task and posttest than would low A-Trait students was confirmed. In addition, state anxiety was found to change during the experimental session, with highest levels being found for all groups at the beginning of the CAI task and during the achievement posttest. Changes in state anxiety, however, were differential for students in the Constructed Response and Reading groups. Conversely to changes in state curiosity found for these groups, the Reading groups had steady decreases in state anxiety during the CAI task, whereas students in the Constructed Response groups had variable increases and decreases in state anxiety during the CAI task. This finding not only supports the inverse relationship between state curiosity and state anxiety predicted by the Optimal Degree of Arousal conceptualization, but also indicates the differential aspects of this relationship for two types of response mode conditions: reading versus constructed response.

The prediction that low state anxious students would make more correct responses on the posttest than high state anxious students was only partially verified, in that there were interactions between levels of state anxiety, instruction conditions, and response modes on posttest performance. That is, whereas there was relatively little difference in the initial posttest performance of low and high posttest A-State students in the Curiosity-Stimulating Instructions conditions, for students in the No Instructions conditions, low posttest A-State students performed better than high posttest A-State students. One effect of the Curiosity-Stimulating Instructions condition, therefore, would seem to be that of attenuating the performance differences of low and high state anxiety groups. In addition, when students were divided into low, medium, and high A-State groups on the basis of their summed state anxiety scores during the CAI task rather than on the basis of their posttest state anxiety scores, low in-task A-State students performed better on the initial posttest than medium or high in-task A-State students in the Constructed Response groups, whereas high in-task A-State students performed better than medium or low in-task A-State students in the Reading groups.

The findings with respect to performance on the remaining technical posttest indicated that instruction conditions had a differential effect on performance dependent upon whether students were in the Reading or Constructed Response groups. Whereas students in the No Instructions conditions performed approximately the same regardless of whether they were in the Reading or Constructed Response groups, Constructed Response students in the Curiosity-Stimulating Instructions condition performed significantly better than Reading students in the Curiosity-Stimulating Instructions condition. Furthermore, when students were divided into low, medium, and high state curious groups on the basis of their state curiosity scores on the SECS measure given at the end of the experimental session, differential effects of instruction conditions and levels of posttask state curiosity on remaining technical posttest performance were found. That is, the difference in performance of low, medium, and high posttask state curious students in the Curiosity-Stimulating Instructions conditions was relatively small, whereas high posttask state curious students in the No Instructions conditions performed better than medium and low posttask state curious students in the No Instructions conditions on the remaining technical portion of the posttest.

In general, therefore, whereas there was no main effect of the Curiosity-Stimulating Instructions condition on increasing state curiosity, reducing state anxiety, or improving performance, this condition appears to have had the cumulative effect of improving performance for high state anxious students. In addition, the effect of the Curiosity-Stimulating Instructions was more pronounced for students in the Constructed Response groups, indicating that the provision of such instructions was particularly helpful when students were required to overtly respond to the learning materials rather than merely required to read the materials.

Before beginning an interpretation of the major experimental findings in the present study, it is instructive to note that the analyses of the effects of trait anxiety and treatment variables on in-task state curiosity scores revealed no differential effects of trait anxiety and treatment variables on state curiosity scores; while trait curiosity, response modes, and measurement periods were found to differentially affect in-task state curiosity scores. In addition, although the analyses that blocked on trait anxiety yielded no significant interactions between treatment variables with respect to in-task state anxiety, a significant interaction was found between levels of trait curiosity and response mode conditions. Further, differential effects of trait curiosity levels and instruction conditions were found on the initial technical posttest, while no such effects were found for the analyses which blocked on trait anxiety. These findings, therefore, suggest the importance of taking trait curiosity into account in a complex learning task where interest is focused on the relationships between curiosity, anxiety, and performance.

It is possible to offer some speculative explanations for two important findings in the present study: (a) the finding that high trait curious students in the Reading groups retained relatively high levels of state curiosity throughout the CAI task, whereas high trait curious students in the Constructed Response groups had decreases in state curiosity during the task; and (b) the finding that low trait curious students in the Curiosity-Stimulating Instructions condition performed better than low trait curious students in the No Instructions condition on the initial technical portion of the posttest.

With respect to the first finding, it seems reasonable to suggest that the less complex nature of the task for the Reading groups and the shorter times required to complete the task (see Appendix F) may have served to maintain state curiosity at a relatively high level. That is, students with high levels of curiosity in the Reading groups could work through the learning materials at a rate that was conditional only upon how fast they could read the materials. In contrast, the requirement that students in the Constructed Response groups overtly respond to complex learning materials, which concommitantly required them to spend more time on the task and tended to increase their state anxiety levels, may have led to decreases in their levels of state curiosity. As Lester (1968) has suggested, response latency should be at a minimum at intermediate levels of arousal (i.e., curiosity), and thus the nature of the task for students in the Constructed Response group may have been frustrating for students high in level of curiosity.

With respect to the finding that low trait curious students in the Curiosity-Stimulating Instructions condition performed better than low trait curious students in the No Instructions condition, whereas high trait curious students performed at a high level regardless of instruction condition, it may be possible that the Curiosity-Stimulating Instructions condition had the initial effect of maintaining attentional processes in that the students were provided with an introduction to the scope, direction, and meaningfulness of the learning materials. Assuming that attentional processes were enhanced for low trait curious students in the Curiosity-Stimulating Instructions condition, this may have had a facilitating effect on performance on the posttest portion covering the initial technical materials which were presented closer in time to the Curiosity-Stimulating Instructions. The additional findings that there were no significant concomitant effects of trait curiosity and Curiosity-Stimulating Instructions on the remaining technical portion of the posttest tends to support the contention that the Curiosity- Stimulating Instructions condition tended to have a reduced effect across time for low trait curious students. The implication of such a finding would seem to be that of providing instructions which stimulate curiosity periodically within the learning task, contingent upon students' level of trait curiosity, as well as decreases in state curiosity, increases in state anxiety, and/or increases in errors.

Although the effects of the Curiosity-Stimulating Instructions condition were a function of both trait curiosity and response modes on the initial portion of the posttest, the effects of this condition were dependent only upon response modes on the remaining technical portion of the posttest. A possible interpretation of the facilitated performance found for students in the Constructed Response groups with Curiosity- Stimulating Instruction relative to the Reading groups on the remaining technical posttest may be related to task variables in the Constructed Response condition, variables such as complexity, which affected not only attentional processes but subsequent arousal levels. For example, Berlyne's (1960, 1963) work with collative stimulus properties suggests that arousal is typically high in very novel or complex situations, in that these situations produce conceptual conflict. Assuming that the Curiosity-Stimulating Instructions condition may have served to reduce task complexity by providing students with a list of the scope and direction of the learning task, arousal may have been reduced to a moderate or optimal level, which resulted in facilitated performance for students in the Constructed Response condition. In contrast, the different task variables operative in the Reading condition (e.g., less complex nature of the task) may have kept arousal levels at lower levels, and the provision of Curiosity-Stimulating Instructions which structured the task further reduced arousal levels and their facilitating effect. The curiosity, anxiety, and performance findings in the present study seem to provide some support for this position, and other investigators have reported performance on a variety of tasks to be best under conditions of intermediate rather than low or high arousal (e.g., Berlyne, 1960; Berlyne, 1964; Coffer & Appley, 1964; Day, 1966).

Although generalizations to other learning materials and other content areas are not fully warranted, it does seem of value to speculate further on what may have been occurring both phenomenologically and behaviorally for students in response mode and instruction conditions in the present study. First, it should be recalled that all students entered the CAI learning task with relatively high levels of state curiosity. These levels remained high initially regardless of whether students initially received specially written curiosity-stimulating instructions or merely a brief rest. Second, the Curiosity-Stimulating Instructions were written to stimulate epistemic or knowledge-seeking behaviors by emphasizing the meaningfulness, novelty, and interestingness of these learning materials on heart disease. Third, the effects of the Curiosity-Stimulating Instructions condition tended to manifest themselves across time in reducing the disruptive effects of high state anxiety on posttest performance. Given these three points, it seems reasonable to suggest that the Curiosity-Stimulating Instructions condition performed a facilitating function similar to that found for advance organizers (Ausubel, 1968; Papay, 1971).

Advance organizers, according to Ausubel (1968), provide mediational organization which facilitates the coding, storage, and retrieval of information. Part of this facilitating effect is due to the fact that advance organizers render new materials more familiar and potentially meaningful by relating the material to what the learner already knows (Ausubel, 1968). Thus, although the Curiosity-Stimulating Instructions were not explicitly designed within the framework of advance organizers, they did emphasize variables common to this concept. In addition, since the disruptive effects of high state anxiety on posttest performance were less pronounced for students given Curiosity-Stimulating Instructions in the Constructed Response group, such pretask organizational instructions may have provided a supplement to the function attributed to epistemic curiosity behaviors–that of enhancing learning and/or permanent storage of information (Berlyne, 1971).

Although this study represents one of the first to investigate the effects of measuring and stimulating state curiosity within a complex CAI task, it is possible to extract several educational implications. One of the most important of these is that students experience differential levels of arousal (i.e., on the curiosity-anxiety continuum of arousal) which affect their performance. Whether or not these arousal levels facilitate or debilitate performance seems to be partially a function of whether students experience the subjective state of curiosity or anxiety, respectively. Thus, one becomes impressed with the importance of not only measuring and stimulating curiosity, but also of maintaining curiosity behaviors during the learning process in an effort to reduce the disruptive effects of anxiety.

In addition, there appear to be differential arousal levels associated with the collative stimulus factors, such as complexity and novelty, inherent in particular kinds of learning tasks. The findings of the present study, for example, seem to indicate that lower levels of arousal are associated with the Reading response mode condition relative to the Constructed Response mode condition. The passive versus active nature of responding in the Reading and Constructed Response modes, respectively, suggests that the arousal-inducing nature of the learning task may not only be a function of the stimulus materials (i.e., content) but is also a function of the response required to the stimulus intensity.

Providing curiosity-stimulating instructions, or other kinds of experimental manipulations of arousal levels which maintain arousal at a moderate level would, therefore, imply the consideration of the nature of the task in terms of its arousal-inducing properties. For tasks which are by nature more arousal-inducing, it may be necessary to decrease arousal by providing students with more information, and thereby reducing subjective uncertainty, task complexity, ambiguity, novelty, etc. (Berlyne, 1960). On the other hand, if the task is of a less arousal-inducing nature, it may be necessary to increase arousal by increasing subjective uncertainty, conceptual conflict, or task complexity, or by introducing stimuli of a surprising nature--all of which are designed to raise arousal levels to an optimal or intermediate level most efficacious for student learning.

Integration of Present Findings Within Optimal Degree of Arousal Conceptualization

One of the most important implications of the present research for educational practice relates to the fact that through the precise measurement of arousal levels, it is possible to determine those optimal affective states which lead to permanent storage of information (e.g., epistemic curiosity). Basic to this process of determining the parameters essential to an optimal learning environment is a theoretical model to guide research efforts in this direction. Thus, the following discussion will attempt to integrate the present findings within an Optimal Degree of Arousal conceptualization; and, in addition, to suggest refinements and extensions of the predictions derived from the One Factor and Two Factor Models presented earlier. The new Optimal Degree of Arousal conceptualization which appears needed on the basis of the present data will be referred to as the Three Factor Model.

The major departure from the Two Factor Model which assumes the existence of two separate motivational systems, diversive curiosity and anxiety, the combination of which produces specific curiosity behaviors (Spielberger & Butler, 1971), is the present assumption that there are three separate motivational states within the Optimal Degree of Arousal concept: diversive curiosity, specific curiosity, and anxiety. It is further assumed that these states are not only differentiated in terms of level or degree of arousal, as predicted by the One Factor Model (Day, 1969), but that these three motivational states are also differentiated in terms of (a) the conditions that induce them, e.g., stimulus intensity; (b) the subjective response to stimulus intensity, e.g., nature of the subjective feelings associated with these three motivational states; (c) their respective interactive relationships; and (d) their differential effects on performance.

The theoretical relationships between the states of diversive curiosity, specific curiosity, and anxiety predicted by the Three Factor Model are graphically shown in Figure 27. Extensions of the principles deduced from the Two Factor Model (Spielberger & Butler, 1971) which can be derived from the Three Factor Model include:

1. The stimulus intensity threshold for the diversive curiosity state is lower than for the specific curiosity state or the anxiety state.
2. The asymptotic level of the anxiety state is greater than either that of the diversive or the specific curiosity states due to the differential hedonic feelings associated with each.
3. The asymptotic levels of the diversive curiosity state is greater than that of the specific curiosity state in that it originates from unpleasant subjective feelings of boredom rather than from a neutral point on the pleasant/unpleasant dimension.
4. The diversive curiosity state grows as a function of increasing stimulus intensity and is associated with decreasing subjective feelings of unpleasantness and increasing subjective feelings of pleasantness.
5. The specific curiosity state grows as a function of decreasing stimulus intensity and is associated with increasing subjective feelings of pleasantness.
6. The anxiety state grows as a function of increasing stimulus intensity and is associated with increasing subjective feelings of unpleasantness.
7. The resultant curve is produced by subtracting the absolute values of the diversive curiosity curve, specific curiosity curve, and anxiety curve, and closely approximates the inverted-U function shown in Figure 2 (i.e., the Two Factor Model).
8. The resultant curve exemplifies that with increasing stimulus intensity, subjective feelings increase in pleasantness to an optimal level, decrease to a point of indifference, and then become increasingly unpleasant.
9. The diversive curiosity state is conceptualized as motivating stimulus-seeking behavior, the specific curiosity state is conceptualized as motivating information-seeking behavior, and the anxiety state is conceptualized as motivating stimulus-avoidance behavior.

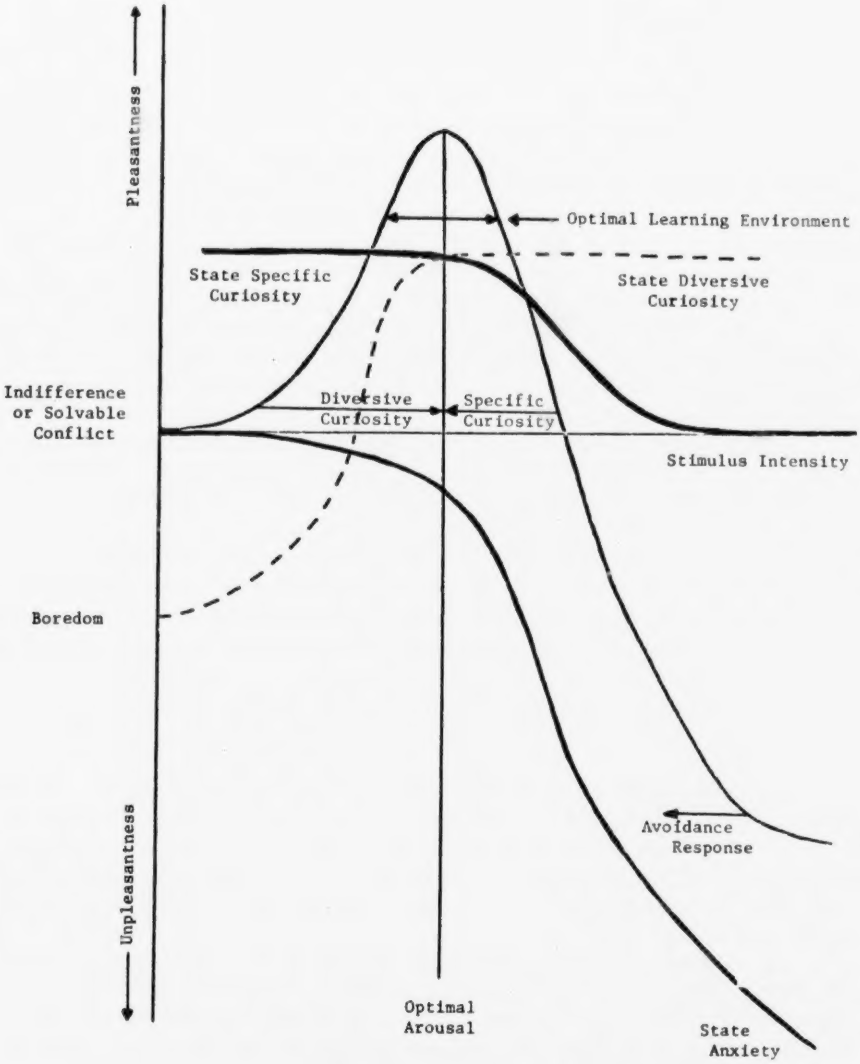

Pleasantness
Unpleasantness
Optimal Learning Environment
State Specific Curiosity
State Diversive Curiosity
Indifference or Solvable Conflict
Diversive Curiosity
Specific Curiosity
Stimulus Intensity
Boredom
Avoidance Response
Optimal Arousal
State Anxiety

Figure 27.—A diagrammatic representation of the Three Factor Model for predicting relationships between state diversive curiosity, state specific curiosity, and state anxiety within the Optimal Degree of Arousal concept.

10. The activation of any one of the three motivational states is partially a function of stimulus intensity, and partially a function of different subjective feeling states. That is, diversive curiosity is induced by feelings of boredom associated with unpleasant feelings; specific curiosity is induced by feelings of solvable perceptual or conceptual conflict and/or uncertainty associated with a neutral combination of pleasant and unpleasant feelings; and anxiety is induced by subjective feelings of unsolvable conflict and/or uncertainty associated with unpleasant feelings.

Within the conceptual framework of the Three Factor Model, it is important to recognize that the states of diversive curiosity, specific curiosity, and anxiety reflect differential trait characteristics of the individual which predispose him to experience these respective state reactions as a function of his past experiences with varying stimulus intensities. In addition, the inverse relationships between curiosity and anxiety are stronger for specific curiosity than for diversive curiosity because specific curiosity grows in the direction of reducing stimulus intensity, and concomitantly conceptual conflict and/or uncertainty, whereas both diversive curiosity and anxiety grow in the direction of increasing stimulus intensity. Thus, the antagonistic relationship between specific curiosity and anxiety is a function of the opposing directions of the response.

On the other hand, the antagonistic relationship between diversive curiosity and anxiety is less pronounced because (a) unpleasant feeling states are associated with both boredom (diversive curiosity) and unsolvable conflict (anxiety); (b) the direction of the response is in the direction of increasing stimulus intensity for both diversive curiosity and anxiety; and (c) diversive curiosity shares some of the same hedonic feeling properties associated with anxiety (i.e., unpleasantness), whereas specific curiosity does not. Since the growth of specific curiosity is in the direction of reducing stimulus intensity and the reduction of unpleasant feelings associated with high levels of anxiety, anxiety is, therefore, decreased more markedly in specific curiosity drive than in diversive curiosity drive.

It should also be noted concerning the Three Factor Model shown in Figure 27, that the asymptotic levels for the diversive curiosity, specific curiosity, and anxiety states are purely theoretical. Empirically, it may be possible that these respective asymptotic levels may be higher or lower than shown, or may show increasing or decreasing levels. Further research is needed to more adequately specify the parameters of these asymptotic levels.

Given the conceptual distinctions between diversive and specific curiosity, and their differential relationships with state anxiety, these two classes of curiosity behaviors would be expected to show different relationships with performance. Whereas specific curiosity, and in particular, epistemic curiosity, would be expected to facilitate performance in a learning situation, diversive curiosity would be expected to be relatively unrelated to performance in a learning task. Considering further the qualities which diversive curiosity shares with anxiety, a slightly negative relationship might be expected between diversive curiosity and performance.

In order to clarify the conceptual refinements and extensions of the Three Factor Model over the One Factor and Two Factor Models, a comparison of the predictions derived from these three models is presented in Table 36. As can be seen in Table 36, the One Factor Model offers predictions relevant only to the relationships between state specific curiosity, state anxiety, and performance. With respect to the predictions derived from the Two Factor Model, they represent an extension of the predictions possible from the One Factor Model in that the relationships between state diversive curiosity, state anxiety, and performance are specified. However, the data collected in the present study suggest that the predicted relationship of the Two Factor Model between state diversive curiosity and state anxiety should be modified; and, in addition, that the predicted relationships between state specific curiosity, state anxiety, and performance be refined. Thus, the new predictions derived from the Three Factor Model are offered as necessary extensions and refinements to those of the One Factor and Two Factor Models on the basis of the present data and the conceptual relationship between diversive and specific curiosity (Berlyne, 1960). Further, the Three Factor Model has retained and integrated those predictions of the One Factor and Two Factor Models which were confirmed by the present study.

The data collected in the present study which support the theoretical assumptions of the Three Factor Model can be summarized as follows. First, an inverse relationship was found between state specific (epistemic) curiosity and state anxiety. However, indirect evidence of the possible relationship between diversive curiosity and anxiety, provided by the correlational data in the present study, indicated that more consistent negative relationships were found between trait specific curiosity (OTIM) scores and state anxiety scores than between trait diversive curiosity (SSS and OTIM Diversive Curiosity Subscale) scores and state anxiety scores. In addition, although significant positive correlations were found between trait specific curiosity and state specific (epistemic) curiosity, no consistent relationship was found between trait diversive curiosity and state specific (epistemic) curiosity.

Assuming that the general relationship between affective traits and states is that individuals high in a particular trait will experience state reactions more frequently and intensely than individuals low in that trait, these correlational data are supportive of the differential interactive relationships between diversive curiosity, specific curiosity, and anxiety. To fully explicate these relationships, however, state measures of diversive curiosity are required.

Additional data collected in the present study which support the predictions of the Three Factor Model regarding the strong inverse relationship between specific (epistemic) curiosity and anxiety are the frequency of students falling into predicted curiosity/anxiety categories. Both the One Factor and Three Factor Models assume that state specific curiosity is associated with intermediate levels of arousal, whereas state anxiety is associated with high levels of arousal. On the other hand, the Two Factor Model assumes that state specific curiosity and state anxiety are associated with high levels of arousal. If it can be assumed that the Reading condition was less arousal producing than the Constructed Response condition, the present data are supportive of the prediction of a greater proportion of students falling into low state curiosity/high state anxiety and high state curiosity/low state anxiety categories than into low state curiosity/low state anxiety and high state curiosity/high state anxiety categories for students in the more stimulus- arousing condition (i.e., Constructed Response mode). In contrast, the frequency data for students in the less stimulus-arousing condition (i.e., Reading mode) were inconclusive in that less consistent curiosity/anxiety category ordering was found.

TABLE 36

A Comparison of the Predictions Derived from the One Factor, Two Factor, and Three Factor Models

Models and Affective States	Predicted Interactive Relationships				
	Diversive Curiosity	Specific Curiosity	Anxiety	Performance	Hedonic Feelings
One Factor					
Diversive Curiosity		No Predictions	No Predictions	No Predictions	No Predictions
Specific Curiosity	No Predictions		*Inverse Relationship	*Intermediate levels of arousal facilitate	Optimal level of Pleasant Feelings
Anxiety	No Predictions	*Inverse Relationship		*High level of arousal debilitating	Unpleasant Feelings
Two Factor					
Diversive Curiosity		No Specific Predictions	***Strong Inverse Relationship	No Predictions	Originates at neutral point of indifference; reaches optimal level of pleasantness
Specific Curiosity	No Specific Predictions		***Low Inverse Relationship	**High level of specific curiosity facilitating when combined with high level of anxiety	Originates with combined feelings of pleasantness and unpleasantness; reaches optimal level of pleasantness

Anxiety	***Strong Inverse Relationship	***Low Inverse Relationship		**High level of arousal debilitating except when combined with high specific curiosity	Originates at neutral point of indifference; becomes increasingly unpleasant
Three Factor					
Diversive Curiosity		*Negligible Relationship	*Low Inverse Relationship	*Negligible to Negative Relationship	Originates with unpleasant feelings ·lings associated with h boredom; reaches optimal level of pleasantness
Specific Curiosity	*Negligible Relationship		*Strong Inverse Relationship	*High level of specific curiosity, intermediate level of arousal facilitating	Originates at neutral point of solvable conflict; reaches optimal level of pleasantness
Anxiety	*Low Inverse Relationship	*Strong Inverse Relationship		*High level of anxiety debilitating; intermediate level of arousal facilitating	Originates at neutral point of conflict; becomes increasingly unpleasant with unsolvable conflict

* Supported with the present data.

** Only partially confirmed with the present data.

*** Not confirmed with the present data.

Also supportive of the relationships predicted between curiosity, anxiety, and performance by the Three Factor Model, are the data which reveal facilitated performance for students in intermediate or moderate levels of arousal categories (i.e., high state curiosity/low state anxiety), rather than low or high levels of arousal categories (i.e., low state curiosity/low state anxiety and high state curiosity/high state anxiety, respectively). These data, however, were more pronounced for students in the Constructed Response groups than for students in the Reading groups. When the differential stimulus-arousing properties of the Reading and Constructed Response mode conditions, as well as the possible differential effects of manipulating arousal levels through Curiosity-Stimulating Instructions, are taken into consideration, the prediction of facilitated performance for high state specific (epistemic) curiosity groups, which were assumed to represent intermediate levels of arousal, is substantiated.

Additional research is needed to specify the relationships predicted between state diversive curiosity and performance in a complex learning task. Suggestive of this relationship, however, is the correlational data collected in the present study between the trait measures of diversive curiosity and posttest performance. These data indicated that the correlations between trait diversive curiosity, as measured by the SSS, and posttest performance ranged from -.08 to -.12. Although these correlations were not significant, they are suggestive of a possible negative relationship between diversive curiosity and performance. In contrast, nonsignificant positive correlations were found between trait specific curiosity and posttest performance, ranging from .06 to .09.

Further research is also needed to clarify (a) the relationship between hedonic feelings (pleasant, unpleasant), state diversive curiosity, state specific curiosity, and state anxiety; and (b) the relationship between hedonic feelings and performance in a learning situation. Conceptually, the relationships of hedonic feelings with curiosity and anxiety states are specified by the Three Factor Model; and it can be assumed that the pleasant feelings associated with state specific (epistemic) curiosity would facilitate performance, whereas the unpleasant feelings associated with state diversive curiosity (boredom) and state anxiety (unsolvable conflict) would not. However, research instruments which measure hedonic levels are required to specify these relationships, thus pointing out the need for research in this direction.

Conclusion

In conclusion, the results of the present study have supported the theoretical relationships between state epistemic curiosity, state anxiety, and performance predicted by the Optimal Degree of Arousal concept. The data were also generally suggestive of the necessity for extending this theoretical model to include three separate motivational states--diversive curiosity, specific curiosity, and anxiety--which are differentially related to each other and to performance in a learning situation.

The Three Factor Model has been offered as a conceptual framework for guiding research efforts on optimization of the learning environment through the consideration of affective states. The essential advantages of the Three Factor Model as a refinement to the Optimal Degree of Arousal concept are (a) its theoretical elaboration of the differential conceptual relationships between diversive curiosity behaviors and specific curiosity behaviors; (b) its specification of the differential theoretical relationships between these two major classes of curiosity behaviors and state anxiety; and (c) its implication of the differential relationships between diversive and specific curiosity in terms of performance in a learning task.

The empirical data collected in the present study have, in addition, demonstrated the reliability and validity of the SECS as a measure of state epistemic curiosity and the feasibility of precise concomitant measurements of epistemic curiosity states and anxiety states during the learning process. Further, the possibility of experimental manipulation of curiosity behaviors has been shown to have potential import in the effort to reduce the disruptive effects of anxiety on performance. Future research directions were suggested for investigating relationships between curiosity behaviors, anxiety, performance, and hedonic feelings predicted by the Three Factor Model. Such research efforts, guided by the suggested conceptual framework, will have their greatest significance in the specification of conditions necessary for optimal learning.

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APPENDICES

APPENDIX A
ORIGINAL VERSIONS OF THE STATE EPISTEMIC CURIOSITY SCALE USED IN STUDIES I AND II

APPENDIX A
ORIGINAL VERSIONS OF THE STATE EPISTEMIC CURIOSITY SCALE USED IN STUDIES I AND II

SECS: STUDY I

Name________________________________ Date________________

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you felt while learning the materials.

There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to best describe how you felt.

	Not at all	Somewhat	Moderately so	Very much so
1. The material I learned was very interesting to me.	1	2	3	4
2. I enjoyed learning the material which was unfamiliar to me.	1	2	3	4
3. I felt that the material was boring.	1	2	3	4
4. When the material was difficult, I did not enjoy learning it.	1	2	3	4
5. I thought it was fun to increase my understanding about the subject matter.	1	2	3	4
6. I would enjoy reading more about this subject matter.	1	2	3	4
7. I would like to see several of the points in the material expanded.	1	2	3	4
8. It was fascinating to me to learn new information.	1	2	3	4
9. When I read an item that puzzled me, I kept reading it until I understood it.	1	2	3	4

Name ______________________________
Page 2

	Not at all	Somewhat	Moderately so	Very much so
10. I enjoyed learning new words and their meanings.	1	2	3	4
11. I found myself getting tired of reading about the same subject.	1	2	3	4
12. When I came across a word I didn't understand I tried to figure out its meaning.	1	2	3	4
13. Sometimes I found it difficult to concentrate on this material.	1	2	3	4
14. On difficult questions I found it difficult to make correct decisions.	1	2	3	4
15. I found myself trying to anticipate what the next problem would be.	1	2	3	4
16. I felt more comfortable when the material was familiar to me.	1	2	3	4
17. I found myself getting upset when the material was redundant.	1	2	3	4
18. I tried to think of alternative answers to some of the problems.	1	2	3	4
19. The material stimulated me to think of new ideas.	1	2	3	4
20. I found that I would rather spend time answering difficult questions than spend it with easy ones.	1	2	3	4

SECS: STUDY II

Name________________________________ Date________________

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then circle the appropriate number to the right of the statement to indicate how you felt while learning the materials.

There are no right or wrong answers.
Do not spend too much time on any one
statement but give the answer which
seems to best describe how you felt.

	Not at all	Somewhat	Moderately so	Very much so
1. The material I learned was very interesting to me.	1	2	3	4
2. I enjoyed learning the material which was unfamiliar to me.	1	2	3	4
3. I felt that the material was boring.	1	2	3	4
4. When the material was difficult, I did not enjoy learning it.	1	2	3	4
5. I thought it was fun to increase my understanding about the subject matter.	1	2	3	4
6. I would enjoy reading more about this subject matter.	1	2	3	4
7. I would like to see several of the points in the material expanded.	1	2	3	4
8. It was fascinating to me to learn new information.	1	2	3	4
9. When I read an item that puzzled me, I kept reading it until I understood it.	1	2	3	4
10. I enjoyed learning new words and their meanings.	1	2	3	4

Name ______________________________
Page 2

	Not at all	Somewhat	Moderately so	Very much so
11. I found myself getting tired of reading about the same subject.	1	2	3	4
12. When I came across a word I didn't understand I tried to figure out its meaning.	1	2	3	4
13. Sometimes I found it difficult to concentrate on this material.	1	2	3	4
14. On difficult questions I found it difficult to make correct decisions.	1	2	3	4
15. I found myself trying to anticipate what the next problem would be.	1	2	3	4
16. I felt more comfortable when the material was familiar to me.	1	2	3	4
17. I found myself getting upset when the material was redundant.	1	2	3	4
18. I tried to think of alternative answers to some of the problems.	1	2	3	4
19. The material stimulated me to think of new ideas.	1	2	3	4
20. I found that I would rather spend time answering difficult questions than spend it with easy ones.	1	2	3	4

APPENDIX B
REVISED LONG AND SHORT FORMS OF THE STATE EPISTEMIC CURIOSITY SCALE USED IN THE PRESENT STUDY

APPENDIX B

REVISED LONG AND SHORT FORMS OF THE STATE EPISTEMIC CURIOSITY SCALE USED IN THE PRESENT STUDY

State Epistemic Curiosity Scale - Form A

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Name______________________________ Date____________________________

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken the appropriate space on the IBM answer sheet to indicate how you think you would feel while learning new materials.

There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe best how you think you would feel.

	Not at all	Somewhat	Moderately so	Very much so
1. The materials will be very interesting to me.	1	2	3	4
2. I will enjoy learning the material which is unfamiliar to me.	1	2	3	4
3. I feel that the material will be boring.	1	2	3	4
4. I will enjoy reading more about the new materials.	1	2	3	4
5. When the material is difficult, I will not enjoy learning it.	1	2	3	4
6. I think it will be fun to increase my understanding about the subject matter.	1	2	3	4
7. I will like to see some of the points in the material expanded.	1	2	3	4
8. I will enjoy learning new words and their meanings.	1	2	3	4

	Not at all	Somewhat	Moderately so	Very much so
9. Sometimes I will find it hard to concentrate on the material.	1	2	3	4
10. It will be fascinating to me to learn new information.	1	2	3	4
11. I will find myself losing interest when complex material is presented.	1	2	3	4
12. When I read a sentence that puzzles me, I will keep reading it until I understand it.	1	2	3	4
13. I will enjoy learning the material that surprises me and makes me change my old ideas about the subject.	1	2	3	4
14. It will be more enjoyable to me to read about familiar than unfamiliar material.	1	2	3	4
15. I will have trouble paying attention on the difficult material.	1	2	3	4
16. The material will stimulate me to think of new ideas.	1	2	3	4
17. I will find that I would rather spend time answering difficult questions than spend it with easy ones.	1	2	3	4
18. When I come across something I don't understand, I will try to figure it out.	1	2	3	4
19. It will be exciting to me to learn about the subject.	1	2	3	4
20. I will find myself getting bored when the material is redundant.	1	2	3	4

State Epistemic Curiosity Scale - Form B

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Name________________________________ Date____________________

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken the appropriate space on the IBM answer sheet to indicate how you felt while learning the materials.

There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe best how you felt.

	Not at all	Somewhat	Moderately so	Very much so
1. The material I learned was very interesting to me.	1	2	3	4
2. I enjoyed learning the material which was unfamiliar to me.	1	2	3	4
3. I felt that the material was boring.	1	2	3	4
4. I would enjoy reading more about this subject matter.	1	2	3	4
5. When the material was difficult, I did not enjoy learning it.	1	2	3	4
6. I thought it was fun to increase my understanding about this subject matter.	1	2	3	4
7. I would like to see some of the points in the material expanded.	1	2	3	4
8. I enjoyed learning new words and their meanings.	1	2	3	4
9. Sometimes I found it hard to concentrate on this material.	1	2	3	4

	Not at all	Somewhat	Moderately so	Very much so
10. It was fascinating to me to learn new information.	1	2	3	4
11. I found myself losing interest when complex material was presented.	1	2	3	4
12. When I read a sentence that puzzled me, I kept reading it until I understood it.	1	2	3	4
13. I enjoyed learning the material that surprised me and made me change my old ideas about this subject.	1	2	3	4
14. It was more enjoyable to me to read about familiar than unfamiliar material.	1	2	3	4
15. I had trouble paying attention on the difficult material.	1	2	3	4
16. The material stimulated me to think of new ideas.	1	2	3	4
17. I found I would rather spend time answering difficult questions than spend it with easy ones.	1	2	3	4
18. When I came across something I didn't understand, I tried to figure it out.	1	2	3	4
19. It was exciting to me to learn about this subject.	1	2	3	4
20. I found myself getting bored when the material was redundant.	1	2	3	4

State Epistemic Curiosity Scale - Form C

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Name ______________________________ Date ____________________

DIRECTIONS: A number of statements which people have used to describe themselves are given below. Read each statement and then blacken the appropriate space on the IBM answer sheet to indicate how you felt during the section of the course you have just completed.

There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe best how you felt.

	Not at all	Somewhat	Moderately so	Very much so
1. The material was very interesting to me.	1	2	3	4
2. I found it difficult to concentrate on this material.	1	2	3	4
3. I thought it was fun to increase my understanding about the subject matter.	1	2	3	4
4. I felt that the material was boring.	1	2	3	4
5. It was fascinating to me to learn new information.	1	2	3	4
6. I enjoyed learning the material which was unfamiliar to me.	1	2	3	4
7. I found myself losing interest when complex material was presented.	1	2	3	4

APPENDIX C
EXAMPLES OF THE INITIAL TECHNICAL AND REMAINING TECHNICAL LEARNING MATERIALS

APPENDIX C
EXAMPLES OF THE INITIAL TECHNICAL AND REMAINING TECHNICAL LEARNING MATERIALS

I. Example of T_I Materials:

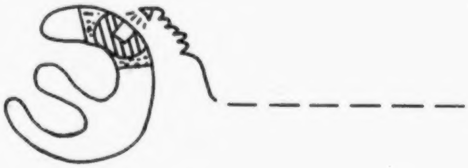
An __________, or __ __ __ for short, is obtained by attaching electrodes to the chest area in front of the heart. The ____________________ pick up the electrical impulses from the heart, and transmit them to the EKG machine via chest leads.

The correct answers are:

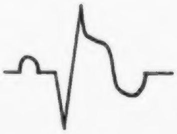
electrocardiogram
EKG
electrodes

II. Example of T_R Materials:

Draw the tracing you would expect.



The correct answer is:



Note: These examples are from the CR versions in which students must respond before receiving the correct answer. Students in the R versions are not required to respond, i.e., response blanks are filled in.

APPENDIX D
RATIONALE AND PROCEDURES FOR SELECTING THE CURIOSITY-STIMULATING INSTRUCTIONS

APPENDIX D
RATIONALE AND PROCEDURES FOR SELECTING THE CURIOSITY-STIMULATING INSTRUCTIONS

The approach to the development and selection of the Curiosity-Stimulating Instructions was both conceptual and empirical. The steps in this approach will be outlined in this appendix.

Steps in Developing and Testing Curiosity-Stimulating Instructions

Step 1. The first step in the developmental phase consisted of conceptualizing three different rhetorical styles for writing curiosity-stimulating instructions:

1. assertive format, i.e., use of questions which (a) related familiar information to students' existing knowledge base, and (b) presented the direction and scope of the new information to be presented.
2. explanatory format, i.e., use of narrative to (a) explain the scope and direction of novel and unfamiliar information, and (b) point out the value of the new information to be acquired.
3. expansive, i.e., use of narrative form to bring in related facts and expand on (a) the familiar or existing information on the incidence and risk of heart disease, and (b) the importance of the new technical information to be presented. Common to each of the three types of curiosity-stimulating passages was the incorporation of the four criteria used in the construction of the state epistemic curiosity scale (see Appendix A).

Step 2. Three curiosity-stimulating passages were written by the investigator according to the above criteria. These passages were referred to as CSI-I, CSI-II, and CSI-III, and are given below.

CSI-I

Did you know that --

Heart disease causes more than half of all deaths in this country?

Major types of heart disease can be identified by electrocardiogram tracings?

The stages of the recovery from heart disease can be traced by the electrocardiogram?

Although you may know the general facts associated with the above statements, the precise technical knowledge concerning heart disease and its diagnosis is probably new to you. For example, do you know —

1. the technical name for the heart muscle?
2. the technical names for the three major types of heart damage?
3. how an electrocardiogram tracing is obtained?
4. how to diagnose heart disease by the electrocardiogram tracing? The answers to these questions and many others are given in the instructional materials you are about to learn.

CSI-II

Most people are familiar with the fact that heart disease is one of the number one killers in this country. However, not too many people understand the complex relationships between the major kinds of heart damage, their associated electrocardiogram (EKG) tracings, and the nature of the healing process.

The materials you will be learning attempt to acquaint you with the technical terms for heart damage, and, in addition, illustrate how accurate diagnoses of heart disease can be made on the basis of EKG tracings. You will learn how EKG tracings are recorded, how to differentiate between EKG tracings, and the stages in the healing process.

The technical terms you will be learning will no doubt be new and unfamiliar to you. However, the material is clearly written to increase your understanding of the complex process of identification, diagnosis, and recovery of heart disease. The information you gain from this learning program should enable you to read in more depth on this subject in the future and possibly help you to avoid the damaging effects of heart disease.

CSI-III

The heart is our most valuable organ, and also the one most vulnerable to disease. Heart disease is the number one killer of the human race, accounting for more fatalities each year than all kinds of cancer put together. Besides being the major cause of death in the United States, countless numbers of people stricken with heart disease are permanently disabled for the rest of their lives.

Heart disease strikes indiscriminantly both young and old, male and female; however, a higher prevalence is found in those over 50 years of age, and over twice as many men as women suffer fatal heart attacks. Nevertheless, it is not unusual to hear reports of both men and women in their 20's and 30's succumbing to heart attacks, and the incidence of such occurrences appears to be rising. This could be attributed to sustained stress to the heart or to sudden overloading of the heart muscle, which may be unaccustomed to such heavy strain. Even chronic tension strains the heart and can be considered a risk factor, indicating that occupation plays a crucial role in the development of heart disease.

Because of the vital concern about controlling and eliminating this major killer, more emphasis must be placed on preventative procedures, in order to detect heart disease before it causes a fatal attack or permanent damage. The electrocardiogram (EKG) is an electronic device which enables a trained technician to detect potential heart trouble before it becomes critical. The materials you will be learning are designed to give you a clearer understanding of how medical diagnoses are made on the basis of EKG tracings, as well as providing you with increased technical knowledge about major types of heart damage and the nature of the healing process.

Step 3. The three curiosity-stimulating passages were pilot-tested on a representative population of 51 female undergraduates enrolled in psychology and health education courses at Florida State University, Spring Quarter, 1971. The subjects were randomly given one of the three curiosity-stimulating instructions packages, which consisted of: (a) a short form 5-item state curiosity scale with the instructions, "indicate how you think you would feel while learning new materials;" (b) the curiosity-stimulating passage; and (c) the same short form 5-item state curiosity scale with the instructions, "indicate how you think you would feel while learning technical materials on heart disease." The short form 5-item state curiosity scale consisted of those positive and negative items which had the highest item-remainder correlations in two previous studies using the 20-item SECS scale (Leherissey, et al., 1971a; Leherissey, 1971b). These five items were : (a) The material will be very interesting to me; (b) I will find it difficult to concentrate on this material; (c) It will be fun to increase my understanding about the subject matter; (d) I feel that the material will be boring to me; and (e) It will be fascinating to me to learn new information.

Step 4. Total increases in state curiosity between the pre and post curiosity-stimulating passage SECS scales were calculated for the three groups of subjects. Results of this calculation indicated that the groups given the assertive format passage (Curiosity-Stimulating Instructions I) had an increase in state curiosity of 5 points from pre to post SECS scale; an increase of 1 point in state curiosity from pre to post SECS scale was found for the group given the explanatory format passage (Curiosity-Stimulating Instructions II); the groups given the expansion format passage (Curiosity-Stimulating Instructions III) had a decrease of 7 points in state curiosity from the pre to post SECS scale.

Step 5. On the basis of the above findings, the Curiosity-Stimulating Instructions I passage was chosen for use in the present study. Although the three passages were differentiated in terms of amount of increase or decrease produced in state curiosity, substantial increases in state curiosity were not noted for any of the passages. For this reason, the following additional step was taken.

Step 6. Students who had participated in the pilot testing were contacted by telephone and asked for further reactions to the curiosity-stimulating passages. The more interesting student comments included: (a) the suggestion from several students that the word "technical" be replaced by "medical" to avoid any negative connotations associated with technical learning materials and to make the materials seem more interesting and meaningful; (b) the opinion of the majority of students presented the assertive format that this format caught their attention and interest; (c) the objection by several students to the term "heart disease" because of the negative connotation associated with disease, and the suggestion that this term be replaced with "heart damage"; and (d) the suggestion by several students that the passage might be made more relevant by the inclusion of what kinds of new information would be learned, i.e., more explicit delineation of the scope and direction of the learning materials.

Step 7. The student protocol information collected in the preceding step was taken into consideration in the revision of the Curiosity-Stimulating Instructions I passage. The revised passage used in the present study is shown below.

Frame 1

Did you know that --

Heart damage causes more than half of all deaths in this country?
Major types of heart damage can be identified by electrocardiogram tracings?

The stages of recovery from heart damage can be traced by an electrocardiogram? Although you may know the general facts associated with the above statements, the precise medical knowledge concerning heart damage and its diagnosis is probably new to you.

Frame 2
For example, do you know ---

1. the medical name for the heart muscle?

2. the medical names for the three major types of heart damage?

3. how an electrocardiogram tracing is obtained?

4. how heart damage is diagnosed by an electrocardiogram tracing?

5. how long it takes to recover from major heart damage?

Frame 3
The answers to those questions and many others are given in the instructional materials you are about to learn. For example, you will learn the medical terms for heart damage, how electrocardiogram tracings are recorded, how to differentiate between electrocardiogram tracings, and the stages in the healing process.

Step 8 The instructions on the pre and post SECS scales for students in the Curiosity-Stimulating Instructions condition were also revised in order to insure comparability to the SECS scale instructions given to students assigned to the No Instructions condition in the present study. The instructions on both the pre and post state curiosity scales were revised to ask students to "indicate how you feel right now." Thus, both the Curiosity-Stimulating Instructions and No Instructions conditions had identical instructions on these initial state curiosity scales.

APPENDIX E
EFFECT OF TREATMENT VARIABLES ON PRE-TASK MEASURES

APPENDIX E
EFFECT OF TREATMENT VARIABLES ON PRE-TASK MEASURES

The following analyses were calculated in order to insure that all groups were well-matched on the curiosity and anxiety inventories given prior to the experimental session. The order of the reported analyses on these dependent measures will be: (a) trait specific curiosity (OTIM scores); (b) trait diversive curiosity (SSS scores); (c) trait anxiety (STAI A-Trait scores); (d) state curiosity (SECS scores); and (e) state anxiety (STAI A-State scores).

Effects of Response Mode and Instruction Conditions on OTIM Scores for Low and High Trait Anxious Students

In order to determine the effects of response modes, instruction conditions and levels of A-Trait on trait specific curiosity, as measured by the OTIM (Day, 1969c), a 2 x 2 x 2 analysis of variance was calculated. Independent variables in this analysis were response mode conditions (R, CR), instruction conditions (CSI, NI), and A-Trait levels (LA, HA). The dependent variable was mean OTIM scores.

The means and standard deviations of trait specific curiosity for low and high A-Trait students in response mode and instruction conditions are given in Table 37.

TABLE 37

Mean OTIM Scores for Low and High A-Trait Students in Response Mode and Instruction Conditions

Groups	Trait Anxiety Levels	
	Low	High
Reading - CSI (n=38)		
Mean	291.21	293.16
SD	38.76	37.51
Reading - NI (n=38)		
Mean	297.05	286.37
SD	40.29	31.76
Constructed Response - CSI (n=38)		
Mean	288.58	295.63
SD	41.38	43.45
Constructed Response - NI (n=38)		
Mean	292.47	293.89
SD	42.98	31.16

Results of the analysis of variance on these data revealed no significant main effects or interactions. The low and high A-Trait students in response mode and instruction conditions were thus well-matched on trait specific curiosity, as measured by the OTIM.

Effects of Response Mode and Instruction Conditions on Sensation Seeking Scale Scores for Low and High Trait Anxious Students

To examine the effects of treatment conditions and levels of A-Trait on trait diversive curiosity, as measured by the SSS (Zuckerman, et al., 1965) given prior to the experimental session, a 2 x 2 x 2 analysis of variance was calculated. The independent variables in this analysis were response modes (R, CR), instruction conditions, and A-Trait levels (LA, HA). The dependent variable was mean scores on the SSS.

The means and standard deviations of SSS scores for low and high trait anxious students in response mode and instruction conditions are presented in Table 38.

TABLE 38

Mean Sensation Seeking Scale Scores for Low and High A-Trait Students in Response Mode and Instruction Conditions

Groups	Trait Anxiety Levels	
	Low	High
Reading - CSI (n=38)		
Mean	44.16	44.26
SD	3.39	2.35
Reading - NI (n=38)		
Mean	44.16	44.74
SD	2.24	2.49
Constructed Response - CSI (n=38)		
Mean	43.95	43.42
SD	2.55	2.61
Constructed Response - NI (n=38)		
Mean	44.58	44.11
SD	3.81	2.00

Results of the analysis of variance on these data revealed no significant main effects or interactions. Thus, low and high A-Trait students in response mode and instruction conditions were well-matched on trait diversive curiosity, as measured by the SSS.

A similar 2 x 2 x 2 subsidiary analysis of variance was calculated to determine the effects of treatment conditions and levels of trait curiosity on mean SSS scores, reported in Table 39.

TABLE 39

Mean Sensation Seeking Scale Scores for Low and High
Trait Curious Students in Response
Mode and Instruction Conditions

Groups	Trait Curiosity Levels Low	Trait Curiosity Levels High
Reading - CSI (n=38)		
Mean	44.26	44.16
SD	2.56	3.24
Reading - NI (n=38)		
Mean	44.95	43.95
SD	2.12	2.53
Constructed Response - CSI (n=38)		
Mean	43.74	43.63
SD	2.90	2.24
Constructed Response - NI (n=38)		
Mean	44.16	44.53
SD	2.32	1.84

The independent variables in the analysis were response modes (R, CR), instruction conditions (CSI, NI), and levels of trait curiosity (LC, HC). The dependent variable was again mean scores on the SSS.

Results of this analysis indicated, as in the previous analysis, that there were no significant main effects or interactions. The low and high trait curious students in response mode and instruction conditions were, therefore, found to be well-matched on trait diversive curiosity.

Effects of Response Mode and Instruction Conditions on A-Trait Scores for Low and High Trait Curious Students

To insure that students in response mode and instruction conditions were well-matched on levels of trait anxiety, a 2 x 2 x 2 analysis of variance was calculated. Independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), and levels of trait curiosity (LC, HC). The dependent variable was mean STAI A-Trait scores.

The means and standard deviations of A-Trait scores for low and high trait curious students in response mode and instruction conditions are presented in Table 40.

Results of the analysis of variance on these data revealed no significant main effects or interactions. Thus, low and high trait curious students in response mode and instruction conditions were well-matched on trait anxiety scores.

TABLE 40

Mean STAI A-Trait Scores for Low and High Trait Curious Students in Response Mode and Instruction Conditions

Groups	Trait Curiosity Levels	
	Low	High
Reading - CSI (n=38)		
Mean	39.58	35.79
SD	10.76	9.73
Reading - NI (n=38)		
Mean	37.26	39.47
SD	7.34	11.58
Constructed Response - CSI (n=38)		
Mean	37.32	37.26
SD	8.60	10.23
Constructed Response - NI (n=38)		
Mean	38.47	36.63
SD	9.90	8.47

Effects of Response Mode and Instruction Conditions on Pretask State Curiosity Scores for Low and High Trait Curious Students

In order to determine whether low and high trait curious students in response mode and instruction conditions were well-matched on the 20-item SECS measure, which asked students to respond with how they thought they would feel while learning new materials and which was given prior to the experimental session, a 2 x 2 x 2 analysis of variance was calculated. Independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), and levels of trait curiosity (LC, HC). The dependent variable in this analysis was mean state curiosity scores on the pretask SECS measure.

The means and standard deviations of pretask SECS scores for low and high trait curious students in response mode and instruction conditions are reported in Table 41.

Results of the analysis of variance on these data indicated that high trait curious students ($\bar{X}$ = 67.03) had significantly higher pretask state curiosity scores than low trait curious students ($\bar{X}$ = 58.30). This main effect of trait curiosity was significant at the $p < .001$ level ($F = 38.39$, $df = 1/144$). No other main effects or interactions approached significance, suggesting that students in response mode and instruction conditions were well-matched on pretask state curiosity scores.

TABLE 41

Mean State Curiosity Scores on the Pretask SECS Measure for Low and High Trait Curious Students in Response Mode and Instruction Conditions

Groups	Trait Curiosity Levels	
	Low	High
Reading - CSI (n=38)		
Mean	58.42	67.84
SD	7.51	7.14
Reading - NI (n=38)		
Mean	58.53	66.00
SD	15.49	7.62
Constructed Response - CSI (n=38)		
Mean	58.74	66.05
SD	5.98	9.32
Constructed Response - NI (n=38)		
Mean	57.53	68.21
SD	7.52	5.69

A similar 2 x 2 x 2 subsidiary analysis was calculated with the independent variables of response modes (R, CR), instruction conditions (CSI, NI), and levels of A-Trait (LA, HA). The dependent variable in this analysis was again mean state curiosity scores on the pretask SECS measure. The means and standard deviations of pretask SECS scores for low and high A-Trait students in response mode and instruction conditions are reported in Table 42.

Results of the analysis of variance on these data revealed no significant main effects or interactions. The low and high A-Trait students in response mode and instruction conditions were, therefore, found to be well-matched on pretask state curiosity scores.

Effects of Response Mode and Instruction Conditions on Pretask State Anxiety Scores for Low and High Trait Anxious Students

To insure that low and high A-Trait students in response mode and instruction conditions were well-matched on the 20-item STAI A-State measure administered prior to the experimental session, a 2 x 2 x 2 analysis of variance was calculated. Independent variables were response modes (R, CR), instruction conditions (CSI, NI), and levels of A-Trait (LA, HA). The dependent variable in this analysis was mean A-State scores on the pretask STAI A-State measure.

TABLE 42

Mean State Curiosity Scores on the Pretask SECS Measure
for Low and High A-Trait Students in Response
Mode and Instruction Conditions

Groups	Trait Anxiety Levels	
	Low	High
Reading - CSI (n=38)		
Mean	65.63	60.63
SD	9.84	6.65
Reading - NI (n=38)		
Mean	62.21	62.32
SD	16.23	11.21
Constructed Response - CSI (n=38)		
Mean	64.37	60.42
SD	7.26	9.13
Constructed Response - NI (n=38)		
Mean	64.05	61.68
SD	9.70	7.23

The means and standard deviations of pretask A-State scores for low and high A-Trait students in response mode and instruction conditions are reported in Table 43.

Results of the analysis of variance on these data indicated that high A-Trait students ($\bar{X}$ = 41.40) had significantly higher pretask A-State scores than low A-Trait students ($\bar{X}$ = 32.76). This main effect of A-Trait was significant at the $p < .001$ level (F = 45.52, df = 1/144). No other main effects or interactions approached significance, indicating that students in response mode and instruction conditions were well-matched on pretask state anxiety scores.

A similar 2 x 2 x 2 subsidiary analysis was calculated on the data presented in Table 44 to determine whether low and high trait curious students in treatment conditions were well-matched on pretask A-State scores. Independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), and levels of trait curiosity (LC, HC). The dependent variable in this analysis was again mean A-State scores on the pretask STAI A-State measure.

Results of the analysis of variance on these data revealed no significant main effects of interactions. Thus, low and high trait curious students in response mode and instruction conditions were found to be well-matched on pretask state anxiety scores.

Summary. The results of the preceding analyses of variance indicated that low and high trait curious and low and high trait anxious students in response mode and instruction conditions were well-matched on trait specific curiosity, trait diversive

TABLE 43

Mean STAI A-State Scores on the Pretask A-State Measure for Low and High A-Trait Students in Response Mode and Instruction Conditions

Groups	Trait Anxiety Levels	
	Low	High
Reading - CSI (n=38)		
Mean	31.58	40.79
SD	7.78	8.64
Reading - NI (n=38)		
Mean	32.11	42.95
SD	5.74	9.03
Constructed Response - CSI (n=38)		
Mean	33.53	38.11
SD	6.12	6.81
Constructed Response - NI (n=38)		
Mean	33.84	43.74
SD	8.03	9.98

curiosity, trait anxiety, state curiosity, and state anxiety, as measured by the inventories administered prior to the experimental session.

TABLE 44

Mean STAI A-State Scores on the Pretask A-State Measure for Low and High Trait Curious Students in Response Mode and Instruction Conditions

Groups	Trait Curiosity Levels	
	Low	High
Reading - CSI (n=38)		
Mean	37.47	34.90
SD	7.77	10.78
Reading - NI (n=38)		
Mean	37.37	37.58
SD	9.20	9.59
Constructed Response - CSI (n=38)		
Mean	36.42	35.21
SD	7.21	6.49
Constructed Response - NI (n=38)		
Mean	40.58	37.00
SD	8.52	11.68

APPENDIX F
EFFECT OF TREATMENT VARIABLES ON TOTAL TIME SPENT ON THE CAI TASK

APPENDIX F
EFFECT OF TREATMENT VARIABLES ON TOTAL TIME SPENT ON THE CAI TASK

The analyses in this appendix investigated the effects of treatment variables on total time spent on the CAI task. These analyses will be divided into two major sections: (a) those analyses which investigate total time as a function of response modes, instruction conditions, and levels of curiosity; and (b) those analyses which investigate total time as a function of response modes, instruction conditions, and levels of anxiety.

I. Curiosity and Learning Time

Effects of Response Mode and Instruction Conditions on Total Learning Time for Low and High Trait Curious Students

A 2 x 2 x 2 analysis of variance was calculated to examine the effects of response modes, instruction conditions, and trait curiosity levels on total time spent on the CAI learning task. Independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), and levels of trait curiosity (LC, HC). The dependent variable was mean learning time in minutes on the CAI program.

The means and standard deviations of total learning times for low and high trait curious students in response mode and instruction conditions on the CAI program are reported in Table 45.

TABLE 45

Mean Learning Times on the CAI Program for Low and High Trait Curious Students in Response Mode and Instruction Conditions

Groups	Trait Curiosity Levels	
	Low	High
Reading - CSI (n=38)		
Mean	35.79	36.47
SD	6.08	6.91
Reading - NI (n=38)		
Mean	38.95	39.26
SD	7.30	8.50
Constructed Response - CSI (n=38)		
Mean	102.16	110.32
SD	18.03	29.34
Constructed Response - NI (n=38)		
Mean	99.37	108.74
SD	17.14	22.05

Results of the analysis of variance on these data indicated that students in the Constructed Response groups ($\bar{X}$ = 105.15) took significantly longer on the instructional materials than students in the Reading groups ($\bar{X}$ = 37.62). This main effect of response modes was significant at the $p < .001$ level (F = 637.03, df = 1/144). No other main effects or interactions were significant.

Effects of Response Mode and Instruction Conditions on Total Learning Time for Low, Medium, and High State Curious Students

In order to determine the effects of state curiosity, response modes, and instruction conditions on total learning time, two sets of 3 x 2 x 2 analyses of variance were calculated. The independent variables in the first analysis were levels of in-task state curiosity (low, medium, high), response modes (R, CR), and instruction conditions (CSI, NI). The independent variables in the second analysis were levels of posttask state curiosity (low, medium, high), response modes (R, CR), and instruction conditions (CSI, NI). The dependent variable in both analyses was mean learning time in minutes on the CAI learning program.

The means and standard deviations of total learning time on the CAI program for low, medium, and high in-task state curious students in response mode and instruction conditions are reported in Table 46. Table 47 gives the means and standard deviations of total learning time for low, medium, and high posttask state curious students in response mode and instruction conditions.

TABLE 46

Mean Learning Times on the CAI Program for Low, Medium and High In-Task State Curious Students in Response Mode and Instruction Conditions

Groups	In-Task State Curiosity Levels		
	Low	Medium	High
Reading - CSI (n=38)			
Mean	37.40	35.93	35.39
SD	5.87	6.82	6.73
Reading - NI (n=38)			
Mean	42.60	37.27	38.54
SD	9.45	8.39	4.96
Constructed Response - CSI (n=38)			
Mean	102.75	102.90	113.67
SD	20.13	15.60	34.04
Constructed Response - NI (n=38)			
Mean	97.93	110.70	106.00
SD	18.43	17.11	23.16

TABLE 47

Mean Learning Times on the CAI Program for Low, Medium, and High Posttask State Curious Students in Response Mode and Instruction Conditions

Groups	Posttask State Curiosity Levels		
	Low	Medium	High
Reading - CSI (n=38)			
Mean	35.70	36.60	35.92
SD	4.90	8.17	5.58
Reading - NI (n=38)			
Mean	37.64	39.28	40.56
SD	7.97	6.66	10.19
Constructed Response - CSI (n=38)			
Mean	105.44	99.85	116.89
SD	16.80	18.90	38.56
Constructed Response - NI (n=38)			
Mean	97.43	109.88	106.94
SD	20.16	17.59	20.67

Results of the analyses of variance on the data presented in Tables 46 and 47 revealed for each analysis only a significant main effect of response modes ($F = 617.51$, $df = 1/140$, $p < .001$; and $F = 614.71$, $df = 1/140$, $p < .001$, respectively). Students in the Constructed Response groups ($\bar{X} = 105.15$) were thus found to take significantly longer on the CAI learning task than students in the Reading groups ($\bar{X} = 37.62$).

II. Anxiety and Learning Time

Effects of Response Mode and Instruction Conditions on Total Learning Time for Low and High Trait Anxious Students

In order to determine the effects of response modes, instruction conditions, and levels of A-Trait on total learning time, a 2 x 2 x 2 analysis of variance was calculated. The independent variables in this analysis were response modes (R, CR), instruction conditions (CSI, NI), and levels of A-Trait (LA, HA). The dependent variable was mean learning time in minutes on the CAI program.

The means and standard deviations of total learning times for low and high A-Trait students in response mode and instruction conditions are presented in Table 48.

Results of the analysis of variance on these data indicated that students in the Constructed Response groups ($\bar{X} = 105.15$) took significantly longer to finish the

TABLE 48

Mean Learning Times on the CAI Program for Low and High A-Trait Students in Response Mode and Instruction Conditions

Groups	A-Trait Levels	
	Low	High
Reading - CSI (n=38)		
Mean	34.84	37.42
SD	6.93	5.78
Reading - NI (n=38)		
Mean	36.42	41.79
SD	7.04	7.80
Constructed Response - CSI (n=38)		
Mean	112.00	100.47
SD	27.24	20.23
Constructed Response - NI (n=38)		
Mean	96.58	11.53
SD	16.91	20.55

instructional program than students in the Reading groups ($\bar{X} = 37.62$). This main effect of response modes was significant at the $p < .001$ level ($F = 671.53$, $df = 1/144$). In addition, two interactions were significant: (a) instruction conditions by A-Trait level ($F = 7.93$, $df = 1/144$, $p < .01$); and (b) response modes by instruction conditions by A-Trait levels ($F = 5.20$, $df = 1/144$, $p < .05$). These interactions are shown in Figures 28 and 29, respectively.

As can be seen in Figure 28, low A-Trait students in the Curiosity-Stimulating Instructions conditions took longer on the instructional program than low A-Trait students in the No Instructions conditions, whereas for high A-Trait students the reverse was true. The triple interaction shown in Figure 29 indicates that whereas there was relatively little difference in mean times for low and high A-Trait students in the Reading-CSI and Reading-NI conditions, dependent upon whether low and high A-Trait students were in the Constructed Response-CSI and Constructed Response-NI conditions, mean time spent on the instructional materials was differentially affected. That is, low A-Trait students in the Constructed Response-CSI condition took longer than low A-Trait students in the Constructed Response-NI condition, whereas the reverse was true for high A-Trait students in the Constructed Response-CSI and Constructed Response-NI conditions. No other main effects or interactions were significant.

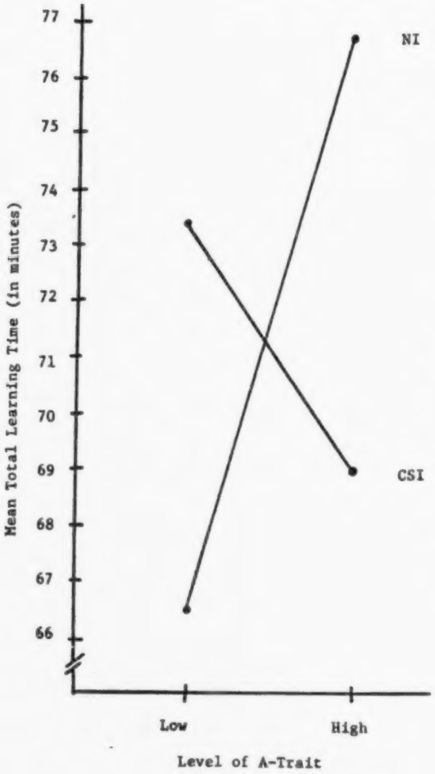


Figure 28.—Instruction conditions by level of trait anxiety interaction on total learning time.

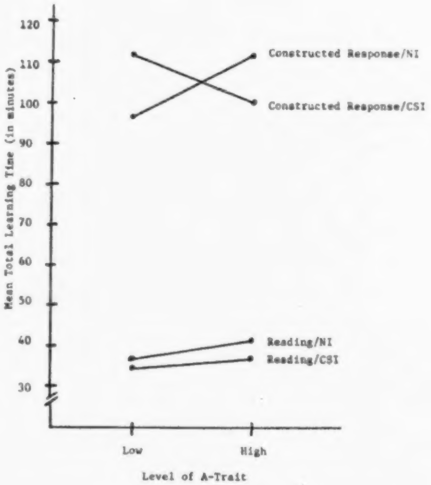


Figure 29.—Response modes by instruction conditions by level of trait anxiety interaction on total learning time.

Effects of Response Mode and Instruction Conditions on Total Learning Time for Low, Medium, and High State Anxious Students

To investigate the effects of state anxiety, response modes, and instruction conditons on total learning time, a 3 x 2 x 2 analysis of variance was calculated. The independent variables in this analysis were levels of in-task state anxiety (low, medium, high), response modes (R, CR), and instruction conditions (CSI, NI). The dependent variable was mean learning time in minutes on the CAI program.

The means and standard deviations of total learning time for low, medium, and high in-task A-State students in response mode and instruction conditions are reported in Table 49.

Results of the analysis of variance on these data indicated that students in the Constructed Response groups ($\overline{X} = 105.15$) took significantly longer on the CAI task than students in the Reading groups ($\overline{X} = 37.62$). This main effect of response

TABLE 49

Mean Learning Times on the CAI Program for Low, Medium, and High In-Task State Anxious Students in Response Mode and Instruction Conditions

Groups	In-Task A-State Levels Low	Medium	High
Reading - CSI (n=38)			
Mean	33.13	36.44	39.62
SD	6.02	5.62	5.98
Reading - NI (n=38)			
Mean	34.75	40.83	44.00
SD	5.69	7.55	7.96
Constructed Response - CSI (n=38)			
Mean	114.09	104.00	102.14
SD	35.29	21.00	15.83
Constructed Response - NI (n=38)			
Mean	95.11	109.79	104.07
SD	20.23	16.60	22.11

modes was significant at the $p < .001$ level ($F = 606.14$, $df = 1/140$). No other main effects or interactions in this analysis were significant.

Summary and discussion. In general, the results of the learning time analyses indicated that students in the Constructed Response groups took approximately three times as long on the CAI learning program as students in the Reading groups. Learning times were not found to be a function of either trait or state curiosity; however, the results of the anxiety and learning time data analyses indicated that total time spent on the CAI task was a function of response modes, instruction conditions, and levels of trait anxiety. That is, although there was little difference in time spent of the learning program for low and high A-Trait students in the Reading-CSI and Reading-NI conditions, differential times were spent on the task by low and high A-Trait students in the Constructed Response-CSI and Constructed Response-NI conditions. The low A-Trait students in the Constructed Response-CSI condition were found to take longer on the task than high A-Trait students in the Constructed Response-CSI condition, whereas the reverse was true for low and high A-Trait students in the Constructed Response-NI condition.

Thus, although students in response mode and instruction conditions were not found to spend differential amounts of time on the CAI task as a function of trait curiosity, state curiosity, or state anxiety, dependent on levels of trait anxiety, response modes, and instruction conditions, students spent differential amounts of time on the task. The provision of Curiosity-Stimulating Instructions which organized the scope and direction of the learning materials appeared to reduce the tendency for high A-Trait students to spend more time on the task, particularly for students in the Constructed Response group.

APPENDIX G
REPLICATION RESULTS OF TWO PREVIOUS CAI STUDIES WITH THE SAME LEARNING MATERIALS

APPENDIX G
REPLICATION RESULTS OF TWO PREVIOUS CAI STUDIES WITH THE SAME LEARNING MATERIALS

This appendix contains analyses calculated in order to replicate two previous CAI findings with the learning materials used in the present study (Leherissey, et al., 1971a, Study I; Leherissey, et al., 1971b, Study II). First, in both Studies I and II, higher levels of state anxiety during the technical learning materials were found for students in the Constructed Response groups relative to students in the Reading groups. Second, the Constructed Response and Reading groups were not found to differ in technical remaining or total technical posttest performance in Studies I and II, although students in the Constructed Response groups were found to perform better than students in the Reading groups on the initial technical posttest in Study II. The analyses addressed to these findings were calculated only on the Reading and Constructed Response groups in the No Instructions condition, in that this condition more closely approximated the response mode conditions in the previous studies. In addition, the analyses will be categorized into those dealing with the anxiety replication results and those dealing with posttest performance replication results.

I. Anxiety Replication Results

Effects of Response Modes on State Anxiety Scored During the Experimental Session for Low and High Trait Anxious Students

In order to investigate the hypothesis that students in the Constructed Response-NI group would have higher levels of state anxiety (a) during the CAI learning task, and (b) achievement posttest than students in the Reading-NI group, two analyses were calculated. The independent variables in the first 2 x 2 x 6 analysis of variance with repeated measures on the least factor were response modes (R, CR), levels of A-Trait (LA, HA), and measurement periods (six short form STAI A-State measures given during the CAI task). The independent variables in the second 2 x 2 analysis of variance were response modes (R, CR) and levels of A-Trait (LA, HA). The dependent variable in the first analysis was mean A-State scores on the six short form in-task A-State measures; mean A-State scores on the achievement posttest was the dependent variable in the second analysis.

The means and standard deviations of A-State scores during the CAI task for low and high A-Trait students in response mode conditions are presented in Table 50.

Results of the analysis of variance on these data indicated that students in the Constructed Response-NI groups ($\bar{X}$ = 9.16) had higher A-State scores than students in the Reading-NI groups ($\bar{X}$ = 8.07). This main effect of response modes was significant at the $p < .05$ level (F = 4.30, df = 1/72). In addition, the main effect of A-Trait was significant (F = 22.73, df = 1/72), indicating that high A-Trait students ($\bar{X}$ = 9.86) had higher A-State scores during the CAI task than low A-Trait students ($\bar{X}$ = 7.36). The main effect of measurement periods was also significant (F = 5.07, df = 5/360, $p < .001$), indicating that A-State scores significantly changed across

TABLE 50

Mean A-State Scores on the Six In-Task STAI A-State Measures for Low and High A-Trait Students in Response Mode Conditions

	Measurement Periods					
Groups	Pre CSI/NI	Post CSI/NI	Post T_I1	Post T_I2	Post T_R1	Post T_R2
LA (n=19)						
Mean	7.47	6.63	6.90	6.37	6.21	6.47
SD	2.42	2.14	2.31	1.74	1.58	2.26
HA (n=19)						
Mean	11.63	9.74	9.21	9.26	8.84	7.84
SD	2.85	3.00	2.89	3.58	3.27	2.71
LA (n=19)						
Mean	8.37	6.58	8.74	8.00	8.32	8.05
SD	3.13	2.59	3.59	3.50	3.28	3.64
HA (n=19)						
Mean	10.90	9.05	10.74	9.74	11.11	10.32
SD	3.07	2.80	2.58	3.62	4.28	4.23

measurement periods. There was also a significant interaction between response modes and measurement periods, which is plotted in Figure 30 ($F = 4.16$, $df = 5/360$, $p < .01$). This interaction indicates that whereas students in both the Reading and Constructed Response groups had high levels of state anxiety initially, which decreased following the No Instructions condition (i.e., brief rest), following the first half of the initial technical materials the Reading group continued to have decreases in state anxiety, but the Constructed Response group had variable increases and decreases in state anxiety.

The means and standard deviation of posttest A-State scores for low and high A-Trait students in response mode conditions are reported in Table 51.

Results of the analysis of variance on the posttest A-State data presented in Table 51 revealed only the main effect of A-Trait ($F = 11.17$, $df = 1/72$, $p < .001$). That is, high A-Trait students ($\bar{X} = 11.61$) had higher state anxiety scores on the posttest than low A-Trait students ($\bar{X} = 8.61$). Although there was a difference in favor of the Constructed Response group ($\bar{X} = 10.55$) having higher state anxiety scores than the Reading group ($\bar{X} = 9.66$), this difference did not approach significance. In addition, the interaction between response modes and levels of A-Trait did not approach significance.

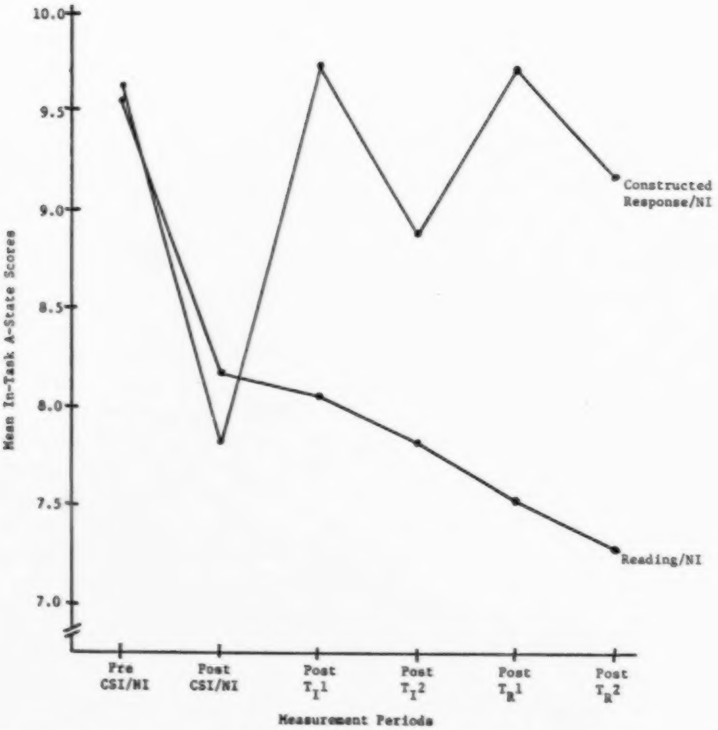


Figure 30.—Response modes by measurement periods interaction on in-task state anxiety scores.

TABLE 51

Mean A-State Scores on the Posttest A-State Measure for Low and High A-Trait Students in Response Mode Conditions

Groups	Trait Anxiety Levels	
	Low	High
Reading - NI (n=38)		
Mean	8.58	10.74
SD	3.76	3.56
Constructed Response - NI (n=38)		
Mean	8.63	12.47
SD	3.98	4.31

II. Posttest Performance Replication Results

Effects of Response Modes on Posttest Performance for Low and High Trait Anxious Students

In order to investigate the hypotheses that (a) students in the Constructed Response group would perform better on the initial technical posttest than students in the Reading group; and (b) there would be no difference in the performance of the Reading and Constructed Response groups on the remaining technical and total technical posttest, three 2 x 2 analyses of variance were calculated. The independent variables in all analyses were response modes (R, CR) and levels of A-Trait (LA, HA). The dependent variable in the first analysis was mean correct responses on the initial technical portion of the posttest; mean correct responses on the remaining technical portion of the posttest was the dependent variable in the second analysis; the dependent variable in the third analysis was mean correct responses on the total technical posttest.

The means and standard deviations of correct responses on the initial technical, remaining technical, and total technical posttest for low and high A-Trait students in response mode conditions are presented in Tables 52, 53, and 54, respectively.

Results of the analysis of variance on the initial technical posttest data presented in Table 52 indicated that students in the Constructed Response group ($\bar{X} = 22.21$) made significantly more correct responses than students in the Reading group ($\bar{X} = 19.29$). This main effect of response modes was significant at the $p < .001$ level ($F = 14.96$, $df = 1/72$). No other main effects or interactions were significant.

Results of the analyses of variance on the remaining technical and total technical posttest data reported in Tables 53 and 54 revealed no significant main effects or interactions.

TABLE 52

Mean Correct Responses on the Initial Technical Posttest for Low and High A-Trait Students in Response Mode Conditions

Groups	Trait Anxiety Levels	
	Low	High
Reading - NI (n=38)		
Mean	19.68	18.90
SD	2.79	3.45
Constructed Response - NI (n=38)		
Mean	23.00	21.42
SD	2.89	3.92

TABLE 53

Mean Correct Responses on the Remaining Technical Posttest for Low and High A-Trait Students in Response Mode Conditions

Groups	Trait Anxiety Levels	
	Low	High
Reading - NI (n=38)		
Mean	36.26	37.47
SD	16.38	17.08
Constructed Response - NI (n=38)		
Mean	36.79	37.68
SD	17.84	19.34

TABLE 54

Mean Correct Responses on the Total Technical Posttest for Low and High A-Trait Students in Response Mode Conditions

Groups	Trait Anxiety Levels	
	Low	High
Reading - NI (n=38)		
Mean	55.95	56.36
SD	17.39	18.86
Constructed Response - NI (n=38)		
Mean	59.79	59.11
SD	19.43	21.66

Summary and discussion. The hypothesis that students in the Constructed Response group would have higher levels of state anxiety during the experimental session than students in the Reading groups was partially supported, in that students in the Constructed Response group had higher state anxiety scores on the CAI learning task but not on the achievement posttest than students in the Reading group. Thus, this finding partially replicated those of Studies I and II. It is interesting to note, however, that state anxiety scores during the CAI task for the Reading and Constructed Response groups in the present study (i.e., $\bar{X} = 8.07$ and $\bar{X} = 9.16$, respectively) were lower relative to the state anxiety scores during the technical CAI task for the Reading and Constructed Response groups in Study I (i.e., $\bar{X} = 9.32$ and $\bar{X} = 12.05$, respectively) and Study II (i.e., $\bar{X} = 8.92$ and $\bar{X} = 10.57$, respectively).

In addition, a comparison of the state anxiety scores during the achievement posttest for the Reading and Constructed Response groups in the present study with the posttest state anxiety scores of the Reading and Constructed Response groups in Studies I and II also indicates that the Reading ($\bar{X}$ = 9.66) and Constructed Response ($\bar{X}$ = 10.55) groups in the present study tended to have lower state anxiety scores during the posttest than the Reading and Constructed Response groups in Study I (i.e., $\bar{X}$ = 10.43 and $\bar{X}$ = 12.97, respectively) and Study II (i.e., $\bar{X}$ = 9.56 and $\bar{X}$ = 11.75, respectively). This tendency for lower posttest state anxiety scores in the present study was particularly true for students in the Constructed Response group.

The analyses which examined the effects of response modes and trait anxiety on posttest performance indicated, as predicted, that students in the Constructed Response group made more correct responses on the initial technical, but not on the remaining technical and total technical posttest, than students in the Reading groups. Thus, the findings of Studies I and II were replicated with respect to posttest performance. A comparison of the means on the three portions of the posttest between the present study and Studies I and II also indicates that there were negligible differences in scores for Reading and Constructed Response groups across these studies.

One possible explanation for both the lower state anxiety scores during the experimental session for Reading and Constructed Response groups in the present study relative to the two previous studies, and the failure to find significant differences in posttest A-State scores for the Reading and Constructed Response groups in the present study, may be due to the fact that the task differed between these studies. In Studies I and II, students were required to learn familiar and technical materials on heart disease. A comparison of the learning times between these studies and the present study indicates that students in the Constructed Response groups in Studies I and II spent approximately twenty minutes longer on the CAI task and Reading students spent approximately ten minutes longer on the CAI task than students in the Reading and Constructed Response groups in the present study. It seems reasonable to suggest that the longer times spent on the task for students in Studies I and II may have served to increase their levels of state anxiety.

Another factor which may have been responsible for the lower state anxiety scores for students in the Reading and Constructed Response groups in the present study relates to the difference in procedures between this and the previous studies. That is, in Studies I and II students "constructed" EKG tracings in the learning program by typing numbers with which segments of the EKG tracing were associated, whereas the posttest was administered via paper and pencil and the students were required to actually draw the EKG tracings. In the present study, however, students constructed EKG tracings on the posttest in the same manner in which they had constructed these tracings in the learning program, i.e., by referring to a handout of EKG tracing segments from which they chose the appropriate sequence of numbers to complete the tracing required. This difference in the nature of the task for students in the present study may thus have contributed to lower state anxiety scores than for students in the two previous studies.

In general, however, the present study replicated the findings of Leherissey et al. (1971a) and Leherissey et al. (1971b). The consistent CAI findings that students in the Constructed Response groups do not perform better than students in the Reading groups on the remaining technical and total technical posttest is contradictory to Tobias' (1968, 1969) findings that the Constructed Response groups performed better than the Reading groups on the technical portion of the posttest when these materials on heart disease were presented via programed instruction (PI).

Several possible explanations for the failure to find significant differences between the Reading and Constructed Response groups in these CAI studies may relate to the intrinsic differences between the CAI and PI presentation modes. For example, although students presented learning materials via PI and via CAI have the opportunity to check their responses with the correct answer, it can be argued that the students learning via PI make their own allowances for synonymous correct responses. In the CAI mode, however, students may attribute greater sophistication to the correct answer feedback supplied by the computer, and be less sure of the correctness of their synonymous answers. In addition, the kinds of skills required of students in the Constructed Response groups presented materials via CAI (e.g., the typing in of answers) versus the kinds of skills required of students in the Constructed Response groups presented materials via PI (e.g., the writing of answers), may lead to differential transfer skills on the achievement posttest. The skills required in the CAI task may be producing a distracting effect which is detrimental to the attentional processes required for effective learning.

The preceding possible explanations are speculative and require additional research to verify their merit. It is interesting to note, however, that when students were provided with Curiosity-Stimulating Instructions in the present study, the Constructed Response group was found to perform significantly better than the Reading group on both the initial technical and remaining technical portion of the achievement posttest. Thus, one means for improving the performance of students in the Constructed Response groups presented materials via CAI may be the provision of special instructions which give them the scope, direction, and meaningfulness of the learning task.

APPENDIX H
EFFECT OF TREATMENT VARIABLES ON CAI LEARNING PROGRAM PERFORMANCE FOR STUDENTS IN THE CONSTRUCTED RESPONSE GROUPS

APPENDIX H

EFFECT OF TREATMENT VARIABLES ON CAI LEARNING PROGRAM PERFORMANCE FOR STUDENTS IN THE CONSTRUCTED RESPONSE GROUPS

The analyses in this appendix investigated the effects of treatment variables on Constructed Response students' performance on the CAI learning program. The analyses are divided into two sections: (a) Curiosity and Learning Program Analyses; and (b) Anxiety and Learning Program Analyses. In the first section, the analyses are further divided into those examining the effects of trait curiosity and instruction conditions on learning program performance, and those examining the effects of in-task state curiosity and instruction conditions on the CAI learning program performance. In the second section, the analyses are also further divided into those examining the effects of trait anxiety and the effects of in-task state anxiety and instruction conditions on learning program performance. In all analyses, response modes was not a factor, since only the Constructed Response groups were required to respond while learning the instructional materials. The Reading groups, it should be recalled, were merely required to read through these instructional materials.

I. Curiosity and Learning Program Analyses

Effects of Instruction Conditions on Learning Program Performance for Low and High Trait Curious Students

In order to investigate the effects of trait curiosity and instruction conditions on performance during the CAI learning program, two 2 x 2 analyses of variance were calculated. The independent variables in both analyses were instruction conditions (CSI, NI) and levels of trait curiosity (LC, HC). The dependent variable in the first analysis was mean correct responses on the initial technical portion of the learning program; mean correct responses on the remaining technical portion of the learning program was the dependent variable in the second analysis.

The means and standard deviation of correct responses on the initial technical and remaining technical portions of the learning program for low and high trait curious students in instruction conditions are reported in Tables 55 and 56, respectively.

Results of the analysis of variance on the initial technical learning program data presented in Table 55 revealed a significant interaction between instruction conditions and levels of trait curiosity ($F = 6.31$, $df = 1/72$, $p < .01$). This interaction is plotted in Figure 31, and indicates that for students in the Curiosity-Stimulating Instructions condition, low trait curious students performed better than high trait curious students, whereas the reverse was true for low and high trait curious students in the No Instructions condition. The main effects of trait curiosity and instruction conditions were not found to be significant.

Results of the analysis of variance on the remaining technical learning program data presented in Table 56 again revealed a significant interaction between instruction conditions and levels of trait curiosity ($F = 7.62$, $df = 1/72$, $p < .001$). This interaction is plotted in Figure 32, and indicates, as on the initial technical portion of the CAI program, that for students in the Curiosity-Stimulating Instructions condition, low trait

TABLE 55

Mean Correct Responses on the Initial Technical Learning Program for Low and High Trait Curious Students in Instruction Conditions

Groups	Trait Curiosity Levels	
	Low	High
Constructed Response - CSI (n=38)		
Mean	62.68	58.58
SD	5.94	6.28
Constructed Response - NI (n=38)		
Mean	56.53	60.79
SD	8.00	8.50

TABLE 56

Mean Correct Responses on the Remaining Technical Learning Program for Low and High Trait Curious Students in Instruction Conditions

Groups	Trait Curiosity Levels	
	Low	High
Constructed Response - CSI (n=38)		
Mean	94.00	83.58
SD	13.61	21.19
Constructed Response - NI (n=38)		
Mean	78.21	91.42
SD	23.32	14.68

curious students performed better than high trait curious students on the remaining technical learning program, whereas the reverse was true for low and high trait curious students in the No Instructions conditions. Neither the main effect of trait curiosity or the main effect of instruction conditions were found to be significant.

Effects of Instruction Conditions on Learning Program Performance for Low, Medium, and High State Curious Students

To investigate the hypotheses that (a) high state curious students would make more correct responses on the CAI learning program than low state curious students, and (b) that students in the Curiosity-Stimulating Instructions condition would make more correct responses than students in the No Instructions condition, two 2 x 3 analyses

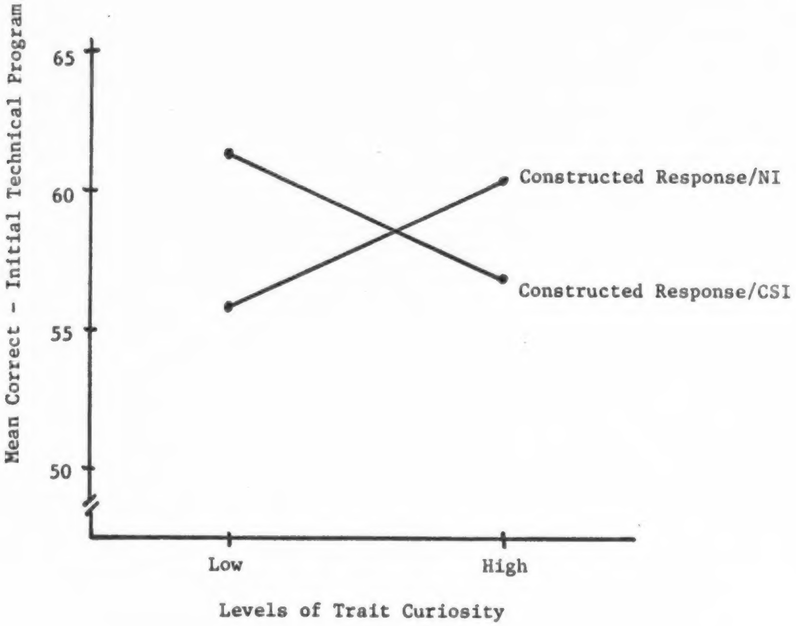


Figure 31.—Instruction conditions by levels of trait curiosity interaction on initial technical learning program scores.

of variance were calculated. Independent variables in both analyses were instruction conditions (CSI, NI) and levels of in-task state curiosity (low, medium, high). The dependent variable in the first analysis was mean correct responses on the initial technical portion of the learning program; mean correct responses on the remaining technical portion of the learning program was the dependent variable in the second analysis.

The means and standard deviations of correct responses on the initial technical and remaining technical learning program for low, medium, and high in-task state curious students in instruction condition are reported in Tables 57 and 58, respectively.

Results of the analysis of variance on the data presented in Table 57 indicated that high state curious students ($\overline{X} = 62.04$) made more correct responses on the initial technical learning program than medium ($\overline{X} = 60.55$) or low ($\overline{X} = 57.13$) state curious students. This main effect of in-task state curiosity was significant at the $p < .05$ level ($F = 3.52$, $df = 2/70$). No other main effects or interactions in this analysis were significant.

Results of the analysis of variance on the remaining technical learning program data presented in Table 58 indicated that high state curious students ($\overline{X} = 95.96$) again made more correct responses than medium ($\overline{X} = 89.55$) or low ($\overline{X} = 77.65$) state curious students. This main effect of in-task state curiosity was significant at the $p < .01$ level ($F = 7.79$, $df = 2/70$). No other main effects or interactions were found to be significant.

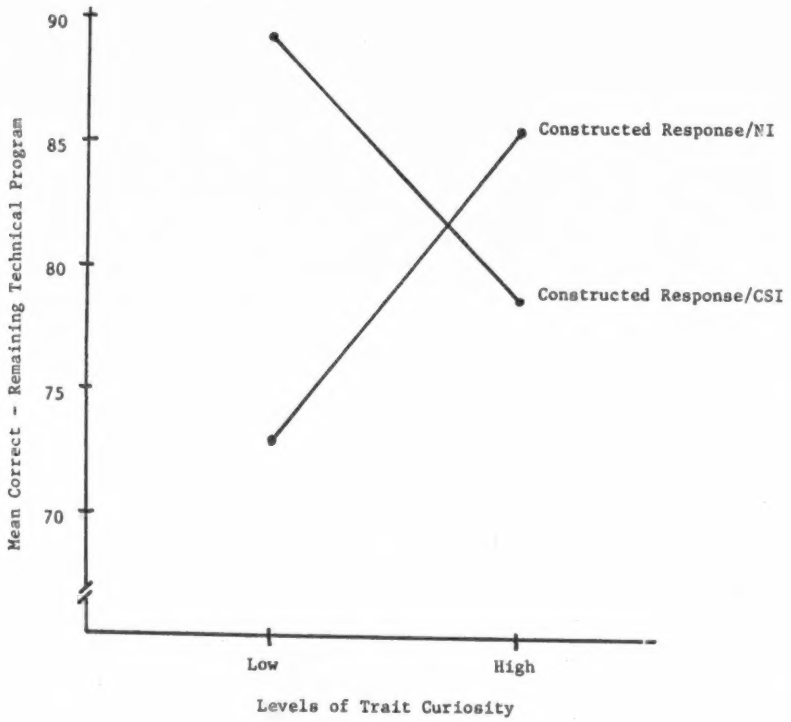


Figure 32.—Instruction conditions by levels of trait curiosity interaction on remaining technical learning program scores.

TABLE 57

Mean Correct Responses on the Initial Technical Learning Program for Low, Medium, and High State Curious Students in Instruction Conditions

Groups	In-Task State Curiosity Levels		
	Low	Medium	High
Constructed Response - CSI (n=38)			
Mean	58.75	60.00	62.57
SD	7.98	4.11	4.54
Constructed Response - NI (n=38)			
Mean	55.40	61.10	60.54
SD	8.46	7.22	8.61

TABLE 58

Mean Correct Responses on the Remaining Technical Learning Program for Low, Medium, and High State Curious Students in Instruction Conditions

Groups	In-Task State Curiosity Levels Low	Medium	High
Constructed Response - CSI (n=38)			
Mean	82.88	88.50	96.92
SD	20.40	19.88	10.83
Constructed Response - NI (n=38)			
Mean	72.07	90.60	95.08
SD	21.90	12.14	16.19

II. Anxiety and Learning Program Analyses

Effects of Instruction Conditions on Learning Program Performance for Low and High Trait Anxious Students

Two 2 x 2 analyses of variance were calculated to determine the effects of trait anxiety and instruction conditions on CAI learning program performance. Independent variables were instruction conditions (CSI, NI) and levels of A-Trait (LA, HA). The dependent variable in the first analysis was mean correct responses on the initial technical portion of the learning program; mean correct responses on the remaining technical portion of the learning program was the dependent variable in the second analysis.

The means and standard deviations of correct responses on the initial technical and remaining technical portions of the learning program for low and high A-Trait students in instruction conditions are presented in Tables 59 and 60, respectively.

Neither the results of the analysis of variance on the data presented in Table 59, nor the results of the analysis of variance on the data presented in Table 60 revealed any significant main effects or interactions.

Effects of Instruction Conditions on Learning Program Performance for Low, Medium, and High State Anxious Students

In order to investigate the hypothesis that low A-State students would make more correct responses on the CAI learning program than high A-State students, two 2 x 3 analyses of variance were calculated. The independent variables in both analyses were instruction conditions (CSI, NI) and levels of in-task A-State (low, medium, high). The dependent variable in the first analysis was mean correct responses on the initial technical portion of the learning program; mean correct responses on the remaining technical portion of the learning program was the dependent variable in the second analysis.

TABLE 59

Mean Correct Responses on the Initial Technical Learning Program for Low and High Trait Anxious Students in Instruction Conditions

Groups	Trait Anxiety Levels	
	Low	High
Constructed Response = CSI (n=38)		
Mean	60.21	61.05
SD	6.13	6.75
Constructed Response - NI (n=38)		
Mean	58.16	59.16
SD	9.23	7.75

TABLE 60

Mean Correct Responses on the Remaining Technical Learning Program for Low and High Trait Anxious Students in Instruction Conditions

Groups	Trait Anxiety Levels	
	Low	High
Constructed Response - CSI (n=38)		
Mean	92.05	85.53
SD	16.78	19.69
Constructed Response - NI (n=38)		
Mean	83.84	85.79
SD	21.39	19.79

The means and standard deviations of correct responses on the initial technical and remaining technical portions of the learning program for low, medium, and high in-task state anxious students in instruction conditions are reported in Tables 61 and 62, respectively.

Results of the analysis of variance on the initial technical learning program data in Table 61 revealed no significant main effects or instructions.

Results of the analysis of variance on the remaining technical learning program data presented in Table 62 indicated that low A-State students ($\overline{X}$ = 94.90) made more correct responses on this portion of the learning program than medium ($\overline{X}$ = 89.56) or high ($\overline{X}$ = 78.65) A-State students. This main effect of in-task state anxiety was

TABLE 61

Mean Correct Responses on the Initial Technical Learning Program for Low, Medium, and High In-Task A-State Students in Instruction Conditions

Groups	In-Task A-State Levels Low	Medium	High
Constructed Response - CSI (n=38)			
Mean	63.91	61.23	57.50
SD	4.48	7.14	5.76
Constructed Response - NI (n=38)			
Mean	59.78	59.86	56.87
SD	10.81	7.89	7.56

TABLE 62

Mean Correct Responses on the Remaining Technical Learning Program for Low, Medium, and High In-Task A-State Students in Instruction Conditions

Groups	In-Task A-State Levels Low	Medium	High
Constructed Response - CSI (n=38)			
Mean	99.27	90.31	79.14
SD	7.70	12.43	23.95
Constructed Response - NI (n=38)			
Mean	89.56	88.86	78.20
SD	25.43	17.69	18.89

significant at the $p < .05$ level ($F = 4.74$, $df = 2/70$). No other main effects or interactions in this analysis were found to be significant.

Summary and discussion. The results of the curiosity and learning program analyses indicated that dependent on instruction conditions and levels of trait curiosity, students performed differentially on the initial technical and remaining technical portions of the CAI learning program. That is, a positive relationship was found between performance and trait curiosity for students in the No Instructions condition, with high trait curious students performing better than low trait curious students on both portions of the learning program. On the other hand, for students in the Curiosity-Stimulating Instructions condition, the performance of low trait curious students was better than that of high trait curious students on the initial technical and remaining technical portions of the learning program. Thus, although there was no main effect of stimulating state epistemic curiosity for the Constructed Response groups on the CAI task, the performance of low trait curious students given curiosity-stimulating instructions was facilitated to a great extent relative to the other trait curiosity groups in instruction conditions.

As predicted, high in-task state curious students were found to make more correct responses on both the initial technical and remaining technical portions of the CAI materials than medium or low in-task state curious students. The inferred relationship between performance and state epistemic curiosity, as derived from the Optimal Degree of Arousal Model, was, therefore, substantiated in relation to learning program performance. It should be recalled that this relationship was also found between state curiosity and performance on the achievement posttest.

With regard to the results of the anxiety and learning program analyses, neither trait anxiety nor instruction conditions were found to affect learning program performance. In addition, the hypothesis that low state anxious students would make more correct responses on the CAI learning program than high state anxious students was only partially supported. That is, the predicted relationship between state anxiety and performance was found on the remaining technical, but not on the initial technical, portion of the learning program. One possible explanation for this finding may have been due to the fact that levels of state anxiety in the present study for students in the Constructed Response groups were relatively moderate (i.e., ($\bar{X}$ = 8.94) during the CAI tsk. In contrast, previous studies with these learning materials (Leherissey, et al., 1971a; Leherissey, et al., 1971b) have found higher state anxiety levels (i.e.,($\bar{X}$ = 12.10 and $\bar{X}$ = 10.95, respectively during the technical CAI learning materials. The lower levels of state anxiety found in the present study may, therefore, have minimized the debilitating effects of anxiety on performance.

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Research Associate, Computer-Assisted Instruction Center, Florida State University, September, 1971 to November, 1971.

Post doctoral research position with responsibility for independent research activities on the effects of affective states on learning. Directed and consulted on projects which extended research on state epistemic curiosity, state anxiety, and performance in complex CAI learning tasks. Worked on the revision of the State Epistemic Curiosity Scale (SECS: Leherissey, 1971).

Research Assistant, Computer-Assisted Instruction Center, Florida State University, April, 1971 to September, 1971.

Responsible for the directing, experimental design, implementation, and data analysis of two research studies funded by the Office of Education for the grant entitled, "The Effects of Anxiety Reduction Techniques on State Anxiety and Performance in

Computer-Assisted Learning and Evaluation." Included administrative duties, technical report writing, and proposal writing. Experience in developing undergraduate Computer-Managed Instruction (CMI) course in educational psychology, including construction of personality-motivation module, behavioral objectives, and criterion-referenced test items.

Graduate Research Assistant, Computer-Assisted Instruction Center, Florida State University, September, 1969 to April, 1971.

Experience in the directing of educational research activities, including responsibility for experimental design, statistical analyses, design of instructional materials, test and personality inventory construction. Participated in the preparation of the following two research proposals: "Development of a Piagetian Sequential Testing Model for Computer Presentation to Elementary School Children" submitted to the National Institute of Mental Health; and "The Effects of Anxiety Reduction Techniques on State Anxiety and Performance in Computer-Assisted Learning and Evaluation" funded by the United States Office of Education. Specific research experience in Computer-Assisted learning and the effects of personality variables on performance (e.g., anxiety, curiosity, and aggression). Experience in the development and validation of an affective personality inventory, the State Epistemic Curiosity Scale (Leherissey, 1971).

U.S. Office of Education Fellow in Computer-Assisted Instruction, Florida State University, September, 1968 to September, 1969.

Received extensive training in educational technology, individualized instruction, CAI programming languages, data analysis procedures, experimental design, implementation, and evaluation procedures for CAI and CMI, e.g., the Systems Approach. Additional training areas included developmental psychology, tests and measurement, statistics and experimental design for education and psychology.

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